TAB J
PART 8

DATA COMMUNICATION RECEIVER UTILIZING A LOOP ANTENNA HAVING A HINGED CONNECTION

FIELD OF THE INVENTION

This invention relates in general to antennas, and more specifically to a loop antenna having a hinged connection for use with a card type data communication receiver.

BACKGROUND OF THE INVENTION

Conventional data communication receivers utilize many types of antennas for receiving signals having specific frequencies. Typically, antenna size and shape varies with both the frequency of the signals the antenna is to receive and the size and shape of the data communication receiver which houses the antenna. For instance, in many low frequency applications, the antenna takes the form of a wire connected to the receiver. In VHF and UHF bands, antennas are often shaped such that an electrical loop is formed by the antenna. In each case, however, the antenna must not only function electrically, but also physically fit into the data communication receiver.

As data communication receivers have become smaller and more complex, the space available for accommodating an antenna has decreased. One solution to this problem is to reduce the size of the antenna. This cannot always be done, however, without adversely affecting the electrical performance of the data communication receiver. A further solution to this problem, then, is to change the shape, rather than the size, of the antenna.

Along these lines, one conventional data communication receiver is designed such that the antenna is embedded within the housing. As a result, the antenna is held by the housing and no fasteners are necessary to secure the antenna. Thus, space within the housing that would normally be consumed by antenna fasteners, such as screws or clips, may be utilized to accommodate other mechanical and electrical components. The amount of additional space provided by this method, however, is minimal because fasteners are generally relatively small compared to other components utilized by the data communication receiver.

Another conventional data communication receiver, a card type receiver, actually employs the antenna as a portion of the housing. The antenna is formed from two conductive plates, one of which is used as a back cover of the data communication receiver and one of which is used as front cover of the data communication receiver. The plates are held apart by a frame defining the sides of the data communication receiver. Typically, the plates are secured to the frame by a plurality of screws which also electrically couple the two plates. In this manner, space for accommodating the antenna is provided by eliminating the areas of the housing which would normally form the front and back covers. Therefore, the interior of the data communication receiver may be filled with components other than the antenna, a feature that is especially useful in card type receivers, in which space is at a premium.

The use of the screws, however, to secure and electrically couple the antenna plates can create problems, both mechanical and electrical. For instance, the threads of the screws may easily become deformed or worn during assembly of the data communication receiver if the force used to tighten the screws is too great. As a result, the data communication receiver may sometimes be difficult or impossible to disassemble for repair purposes. Conversely, proper electrical performance of the data communication receiver is dependent upon the degree to which each screw is tightened. If, for example, the torque applied to each screw is insufficient, i.e., the screws are not properly tightened, the increase in contact resistance between the two plates may degrade the electrical performance.

Thus, what is needed is an improved method for electrically coupling two antenna plates in a card type receiver. Furthermore, the coupling method should not cause variations in the contact resistance, and therefore variations in the electrical performance, of the antenna.

SUMMARY OF THE INVENTION

A substantially card shaped data communication receiver for receiving radio frequency (RF) signals comprises receiver circuitry for recovering information included in the RF signals and an insulative frame partially defining a space within which the receiver circuitry is enclosed and having a cavity formed therein. A first conductive panel is disposed over a first side of the frame, the first panel having a first coupling member formed thereon, wherein the first coupling member is spring-loaded and formed from a resilient material. A second conductive panel is disposed over a second side of the frame opposite the first side of the frame such that the frame is held between the first and second panels, thereby enclosing the receiver circuitry within the space defined by the frame and the first and second panels. The second panel has a second coupling member formed thereon, and the first and second coupling members are disposed within the cavity formed in the frame. The first coupling member is forced into electrical contact with the second coupling member by the frame such that the first panel is electrically coupled to the second panel when the first and second panels are disposed over the first and second sides, respectively, of the frame. A first conductor electrically couples the first panel and the receiver circuitry to provide the RF signals received by the first panel to the receiver circuitry when the first panel is disposed over the first side of the frame, and a second conductor electrically couples the second panel to the receiver circuitry when the second panel is disposed over the second side of the frame, wherein the first and second panels function as an RF antenna when disposed over the first and second sides, respectively, of the frame.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an illustration of a card shaped data communication receiver in accordance with a preferred embodiment of the present invention.

FIG. 2 is an exploded view of the data communication receiver of FIG. 1 in accordance with the preferred embodiment of the present invention.

FIG. 3 is a side, cutaway view of coupling members utilized to electrically couple top and bottom antenna panels of the data communication receiver of FIG. 1 in accordance with the preferred embodiment of the present invention.

FIG. 4 is a side, cutaway view of coupling members utilized to electrically couple top and bottom antenna panels of a data communication receiver in accordance

with a first alternate embodiment of the present invention.

FIG. 5 is a side view of the data communication receiver of FIG. 1 in accordance with the preferred embodiment of the present invention.

FIG. 6 is a side, cutaway view of a fastener and a conductor utilized to electrically couple receiver circuitry to top and bottom antenna panels of a data communication receiver in accordance with a second alternate embodiment of the present invention.

FIG. 7 is an electrical equivalent circuit of the data communication receiver of FIG. 1 in accordance with the preferred embodiment of the present invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

FIG. 1 is an illustration of a card shaped data communication receiver **100** in accordance with a preferred embodiment of the present invention. The data communication receiver **100** is carried by a user and receives radio frequency (RF) signals. Receiver circuitry included within the data communication receiver **100** recovers selective call messages from the RF signals for subsequent presentation by a display device **105**. The visible presentation of each selective call message may be performed automatically in response to reception of the selective call message or manually in response to user manipulation of controls **110** located on the exterior of the data communication receiver **100**.

Referring next to FIG. 2, an exploded view of the data communication receiver **100** is shown. The data communication receiver **100** comprises a printed circuit (pc) board **205**, on which the receiver circuitry (not shown) is mounted, an insulative frame **210**, and top and bottom rectangular panels **215**, **220**. The top and bottom panels **215**, **220** are preferably formed from stainless steel sheet approximately 0.03 cm thick, which is selectively plated with silver or gold. It may be appreciated, however, that other conductive materials, such as nickel, may be used to form the top and bottom panels **215**, **220**, when suitable plating is used.

The pc board **205** is shaped such that it fits within the frame **210**, which is molded from a material such as polycarbonate and to which the bottom panel **220** is bonded, such as by adhesive bonding or insert molding, at its margin. Additionally, in accordance with the preferred embodiment of the present invention, first and second conductive coupling members **221**, **222** formed at an end of the bottom panel **220** are bonded within cavities **223**, **224** formed within an end of the frame **210**. The pc board **205** is secured to the bottom panel **220**, and thus within the frame **210**, by fasteners, e.g., screws **225**, **226** that are passed through pc board holes **230**, **231**. The pc board holes **230**, **231** are aligned with threaded holes **235**, **236** formed in posts **240**, **241**, which are preferably welded or soldered to the bottom panel **220**.

According to the present invention, the top panel **215** is fastened to the frame at one end by third and fourth conductive coupling members **248**, **249** formed thereon. The third and fourth coupling members **248**, **249**, preferably formed into resilient contacts, are forcibly inserted into the cavities **223**, **224** and, in this position, are surrounded by the first and second coupling members **221**, **222**. The interiors of the cavities **223**, **224**, therefore, and the first and second coupling members **221**, **222** securely hold the third and fourth coupling members **248**, **249** such that they remain in electrical contact with the first and second coupling members **221**, **222**, as will be described in greater detail below. The top panel **215** is further fastened to the frame **210** by screws **251**, **252**, which pass through holes **255**, **256** formed in the top panel **215** and aligned with tapped holes **260**, **261** formed in the frame **210**. The tapped holes **260**, **261** are preferably provided by embedding tapped metallic members, such as insert moldable tapped inserts, in the frame **210** during the molding process. After assembly of the data communication receiver **100**, a battery **275** may be inserted within a battery opening **280** in the frame **210**, thereby electrically contacting and powering the receiver circuitry. When the data communication receiver **100** is properly assembled, a conductive path is formed between the top and bottom panels **215**, **220** and the receiver circuitry, in a manner to be described below, such that the top and bottom panels **215**, **220** function as a loop antenna for receiving RF signals.

FIG. 3 is a side, cutaway view of the electrical coupling of the top and bottom panels **215**, **220** in accordance with the preferred embodiment of the present invention. As described above, the first and second coupling members **221**, **222** formed on the bottom panel **220** are bonded along the interior walls of the cavities **223**, **224** formed in the frame **210**. When the top panel **215** is assembled to the frame **210**, the third and fourth coupling members **248**, **249** forcibly slide into the cavities **223**, **224** and are pressed against the first and second coupling members **221**, **222**. In this manner, the top and bottom panels **215**, **220** are electrically coupled simply by assembling them to the frame **210**. Furthermore, no additional parts, such as the screws utilized by prior art data communication receivers, are necessary to couple the top and bottom panels **215**, **220**. As a result, problems associated with the use of screws to electrically couple the top and bottom panels are eliminated by the data communication receiver **100** in accordance with the preferred embodiment of the present invention. As mentioned above, the most common problems arising from the use of the screws in prior art data communication receivers result from improper tightening of the screws. When the screws are tightened insufficiently, contact resistance between the top and bottom panels increases and performance of the antenna is often degraded. When too great of a force is applied to tighten the screws, the threads of the screws may be deformed, i.e., the screws may be stripped, and become difficult or impossible to remove. Therefore, in the data communication receiver **100** according to the present invention, utilization of the cavities **223**, **224** to securely hold the coupling members together, and thereby electrically couple the top and bottom panels **215**, **220**, allows for proper and consistent electrical coupling between the top and bottom panels **215**, **220** each time the data communication receiver **100** is assembled.

FIG. 4 is a side, cutaway view of the electrical coupling of the top and bottom panels **215**, **220** in accordance with an alternate embodiment of the present invention. As shown, the coupling members formed on the bottom panel **220** may be bonded along all of the interior walls of the cavities **223**, **224**. Therefore, the coupling members formed on the top panel **215**, if curved into substantially cylindrical shapes, will contact the coupling members formed on the bottom panel **220** in multiple locations. It may be appreciated by one skilled in the art, however, that the coupling members formed on the top and bottom panels **215**, **220** may be formed in many different shapes.

Referring next to FIG. 5, a side view of the data communication receiver 100 is shown. In accordance with the preferred embodiment of the present invention, first and second resilient, electrical contacts 505, 510 are soldered to opposite sides of the pc board 205. As described above, the pc board 205 is secured within the frame 210 by the screws 225, 226 which are passed through the pc board holes 230, 231 (FIG. 2) into the posts 240, 241 mounted on the bottom panel 220. When the pc board 205 is secured within the frame 210, the first contact 505 is forcibly held against the bottom panel 220, thereby providing for the transmission of RF signals to a first portion of the receiver circuitry mounted on the pc board 205. When the top panel 215 is assembled to the frame 210, the second contact 510 provides an electrical connection between the top panel 215 and a second portion of the receiver circuitry. In this manner, a conductive path is completed between the top and bottom panels 215, 220 and the receiver circuitry such that the top and bottom panels 215, 220 form a loop antenna for reception of RF signals.

In accordance with the preferred embodiment of the present invention, screws are unnecessary for electrically coupling the receiver circuitry to the top and bottom panels 215, 220. As in the above described connection of the coupling members, therefore, errors resulting from improper tightening of the screws are eliminated. As a result, contact resistance between the receiver circuitry and the top and bottom panels 215, 220 remains consistent. Furthermore, because the electrical performance of the antenna is directly related to the contact resistance, the electrical performance of the antenna also remains consistent.

FIG. 6 is a side, cutaway view of the data communication receiver depicting an alternate embodiment of the connection of the pc board 205 to the top and bottom panels 215, 220. As shown, an exposed portion 602 of the receiver circuitry is held in contact with a conductive post 605 by the screw 225, which is passed through the pc board hole 230 (FIG. 2) into a tapped hole in the post 605. In accordance with the alternate embodiment of the present invention, the post 605 is electrically coupled, e.g., soldered or welded, to the bottom panel 220. Therefore, the exposed portion 602 of the receiver circuitry is electrically coupled to the bottom panel 220. Additionally, the receiver circuitry is electrically coupled to the top panel 215 via a conductor 610 soldered to the pc board 205. The screw 252 is passed through the hole 256 (FIG. 2) in the top panel 215 and further through a hole formed in the conductor 610. The screw 252 forcibly holds the top panel 215 against the conductor 610, thereby providing for the electrical connection between the receiver circuitry and the top panel 215. According to the alternate embodiment of the present invention, therefore, the electrical coupling of the receiver circuitry to the top and bottom panels 215, 220 relies on proper tightening of the screws 225, 252 and thus is subject to inconsistencies in the contact resistance between the receiver circuitry and the top and bottom panels 215, 220. However, employment of the screws 225, 252 to electrically couple the receiver circuitry to the top and bottom panels 215, 220 in accordance with the alternate embodiment of the present invention is useful in situations in which utilization of the first and second contacts 505, 510 (FIG. 5) is not feasible. For instance, in a card shaped data communication receiver having more than one pc board, the interior of the data communication receiver may contain insufficient space for placement of resilient contacts large enough to contact opposite sides of a pc board and the top and bottom panels 215, 220.

FIG. 7 is an illustration of an equivalent circuit of the data communication receiver 100. In accordance with the preferred embodiment of the present invention, an inductive value, L, 705 represents an equivalent circuit of the loop antenna formed by the top and bottom panels 215, 220 (FIG. 5). The inductive value 705 is connected in parallel across a capacitive value, C, 710, which represents a capacitive equivalent circuit within the data communication receiver 100. The inductive value 705 and the capacitive value 710 resonate at a frequency which may be varied according to the capacitive value 710, thereby providing for the reception of RF signals having a frequency equal to that of the resonant frequency. The received RF signals are then coupled to the receiver circuitry 715, which recovers the selective call messages included within the RF signals.

In summary, the data communication receiver in accordance with the preferred embodiment of the present invention utilizes a loop antenna having a hinged connection, i.e., the connection of the coupling members formed on the top and bottom panels. Therefore, the electrical coupling of the top and bottom panels, forming the antenna is performed without the use of additional fasteners, such as screws. As a result, because molded cavities in the frame of the data communication receiver hold the coupling members firmly together, contact resistance between the top and bottom panels remains consistent. Additionally, the electrical performance of the antenna remains consistent.

In conventional data communication receivers, however, the panels employed to form the antenna are often electrically coupled through use of screws. Variations, then, in the contact resistance of the antenna can result from improper tightening of the screws. When the screws are not sufficiently tightened, the contact resistance increases, causing possible degradation in the performance of the antenna. The user of the data communication receiver may perceive this degradation in performance as missed selective call messages. Conversely, when too great of a force is applied to tighten the screws, the threads of the screws may become deformed. As a result, the screws may be difficult or impossible to remove in instances when the data communication receiver needs to be disassembled for repair.

The data communication receiver in accordance with the preferred embodiment of the present invention does not suffer from variations in antenna performance to the same extent as conventional data communication receivers. The more consistent antenna performance results directly from the elimination of the screws employed to couple the top and bottom panels of the antenna. Additionally, even greater consistence in antenna performance may be realized by the elimination of the screws used, in prior art data communication receivers, to couple the antenna to the receiver circuitry.

It may be appreciated by now that there has been provided an improved method for electrically coupling two antenna plates in a card type receiver. Furthermore, the coupling method does not cause variations in the contact resistance, and therefore variations in the electrical performance, of the antenna.

We claim:

1. A substantially card shaped data communication receiver for receiving radio frequency (RF) signals, comprising:

receiver circuitry for recovering information included in the RF signals;

an insulative frame partially defining a space within which the receiver circuitry is enclosed, the frame having a cavity formed therein;

a first conductive panel disposed over a first side of the frame, the first panel having a first coupling member formed thereon, wherein the first coupling member is spring-loaded and formed from a resilient material;

a second conductive panel disposed over a second side of the frame opposite the first side of the frame such that the frame is held between the first and second panels, thereby enclosing the receiver circuitry within the space defined by the frame and the first and second panels, wherein the second panel has a second coupling member formed thereon, and wherein the first and second coupling members are disposed within the cavity formed in the frame and the first coupling member is forced into electrical contact with the second coupling member by the frame such that the first panel is electrically coupled to the second panel when the first and second panels are disposed over the first and second sides, respectively, of the frame;

a first conductor for electrically coupling the first panel and the receiver circuitry to provide the RF signals received by the fist panel to the receiver circuitry when the first panel is disposed over the first side of the frame;

a second conductor for electrically coupling the second panel to the receiver circuitry when the second panel is disposed over the second side of the frame, wherein the first and second panels function as an RF antenna when disposed over the first and second sides, respectively, of the frame.

2. The data communication receiver in accordance with claim 1, wherein the first conductor is a conductive fastener which additionally secures the first panel to the frame.

3. The data communication receiver in accordance with claim 1, wherein the first conductor is a resilient contact formed on the first panel for electrically contacting the receiver circuitry when the first panel is disposed over the first side of the frame.

4. The data communication receiver in accordance with claim 3, further comprising a fastener for securing the first panel to the frame.

5. The data communication receiver in accordance with claim 1, wherein the second conductor is a conductive fastener which additionally secures the second panel to the frame.

6. The data communication receiver in accordance with claim 1, wherein the second conductor is a resilient contact formed on the second panel for electrically contacting the receiver circuitry when the second panel is disposed over the second side of the frame.

7. The data communication receiver in accordance with claim 6, further comprising a fastener for securing the second panel to the frame.

8. A substantially card shaped data communication receiver for receiving radio frequency (RF) signals, comprising:

receiver circuitry for recovering information included in the RF signals;

an insulative frame partially defining a space within which the receiver circuitry is enclosed, the frame having a cavity formed therein;

a first conductive panel disposed over a first side of the frame, the first panel having a first coupling member formed thereon, wherein the first coupling member is spring-loaded and formed from a resilient material;

a second conductive panel disposed over a second side of the frame opposite the first side of the frame such that the frame is held between the first and second panels, thereby enclosing the receiver circuitry within the space defined by the frame and the first and second panels, wherein the second panel has a secon coupling member formed thereon, and wherein the first and second coupling members are disposed within the cavity formed in the frame and the first coupling member is forced into electrical contact with the second coupling member by the frame such that the first panel is electrically coupled to the second panel when the first and second panels are disposed over the first and second sides, respectively, of the frame;

a first conductive fastener coupled between the first panel and the receiver circuitry for securing the first panel to the frame and for providing the RF signals received by the first panel to the receiver circuitry; and

a second conductive fastener coupled between the second panel and the receiver for securing the second panel to the frame such that the first and second panels function as an RF antenna when secured to the frame.

9. A substantially card shaped data communication receiver for receiving radio frequency (RF) signals, comprising:

receiver circuitry for recovering information included in the RF signals;

an insulative frame partially defining a space within which the receiver circuitry is enclosed, the frame having a cavity formed therein;

a first conductive panel disposed over a first side of the frame, the first panel having a first coupling member formed thereon, wherein the first coupling member is spring-loaded and formed from a resilient material;

a second conductive panel disposed over a second side of the frame opposite the first side of the frame such that the frame is held between the first and second panels, thereby enclosing the receiver circuitry within the space defined by the frame and the first and second panels, wherein the second panel has a second coupling member formed thereon, and wherein the first and second coupling members are disposed within the cavity formed in the frame and the first coupling member is forced into electrical contact with the second coupling member by the frame when the first and second panels are disposed over the first and second sides, respectively, of the frame;

a first conductive, resilient contact formed on the first panel for electrically contacting the receiver circuitry to provide the RF signals received by the first panel to the receiver circuitry when the first panel is disposed over the first side of the frame;

a second conductive, resilient contact formed on the second panel for electrically contacting the receiver circuitry when the second panel is disposed over the second side of the frame, wherein the first and second panels function as an RF antenna when disposed over the first and second sides, respectively, of the frame;

a first fastener for securing the first panel to the first side of the frame; and

a second fastener for securing the second panel to the second side of the frame.

* * * * *

US005272596A

United States Patent [19]

Honore et al.

[11] Patent Number: 5,272,596

[45] Date of Patent: Dec. 21, 1993

[54] **PERSONAL DATA CARD FABRICATED FROM A POLYMER THICK-FILM CIRCUIT**

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[73] Assignee: **AT&T Bell Laboratories**, Murray Hill, N.J.

[21] Appl. No.: **720,130**

[22] Filed: **Jun. 24, 1991**

[51] **Int. Cl.**[5] **H05K 1/11**

[52] **U.S. Cl.** **361/633**; 29/846; 29/850; 235/488; 174/257; 428/901

[58] **Field of Search** 29/846, 850; 235/488, 235/492; 174/256-259; 361/400, 408, 414; 428/901

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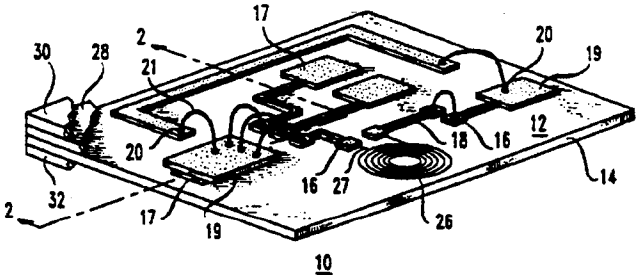
Primary Examiner—P. W. Echols

Attorney, Agent, or Firm—Robert B. Levy

[57] **ABSTRACT**

A personal data card (**10**) is fabricated from a polymer thick-film circuit (**12**) formed of a polymer sheet (**14**) having a plurality of pads (**16** and **17**) and interconnecting paths (**18**) printed thereon with a copper-filled polymer ink. Each of a selected set of the pads (**16**) has a layer of nickel (**22**) applied to it, and then a layer of gold (**24**) applied above the nickel, to facilitate wire bonding of each of a plurality of aluminum leads (**21**), associated with a semiconductor die (**19**), to a corresponding pad. Use of such a polymer thick-film circuit (**12**) in the fabrication of the data card (**10**) reduces the cost of the card.

13 Claims, 1 Drawing Sheet



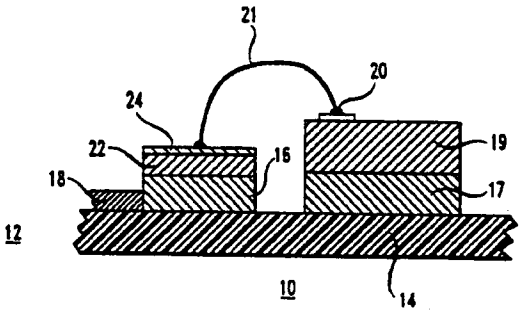


FIG. 1

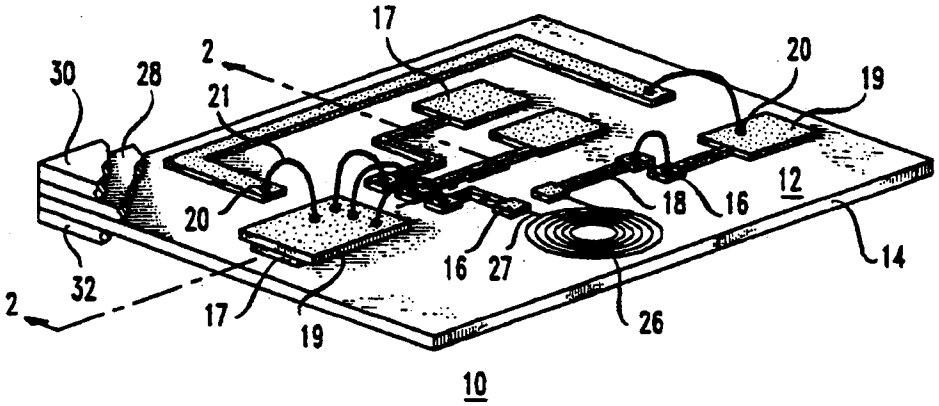

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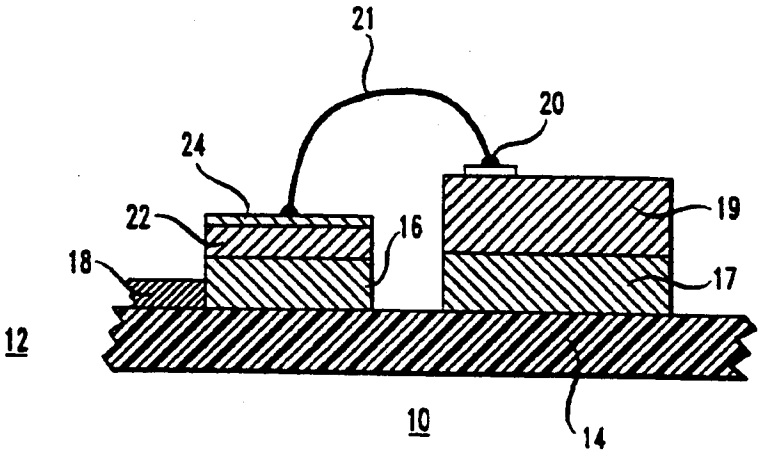
FIG. 2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PERSONAL DATA CARD FABRICATED FROM A POLYMER THICK-FILM CIRCUIT

TECHNICAL FIELD

This invention relates to an electronic memory-type personal data card which is fabricated from a polymer thick-film circuit.

BACKGROUND OF THE INVENTION

Presently, there is much effort being devoted towards the development of a personal data card which is a credit-card-sized device containing an electronic memory for storing data in electronic form. An example of such a personal data card is described in U.S. Pat. No. 4,921,160, issued on May 1, 1990, in the names of Richard Flynn and Fred Verdi, and assigned to AT&T. In the past, personal data cards have been fabricated from a conventional circuit board, made from FR-4 or a polyester resin, which has a layer of metallization of copper or the like clad to one or both of its major surfaces. The copper metallization is patterned, typically by photolithographic techniques, to yield a circuit comprised of a plurality of metallized pads and conductive paths selectively interconnecting the pads. In practice, the metallized pads are selectively plated first with nickel and then gold to facilitate wire bonding of each of a plurality of aluminum leads of a semiconductor die to the circuit board.

While the use of FR-4 or polyester resin-based circuit boards in the fabrication of personal data cards is widespread, the cost of such circuit boards often represents a sizable fraction of the overall cost of the card itself. For this reason, efforts have been focused on employing a less expensive interconnection media in the fabrication of a personal data card. One type of interconnection media which offers a cost advantage over conventional FR-4 and polyester resin-based circuit boards is a polymer thick-film circuit. Such circuits are typically comprised of a sheet of polymer (e.g., MYLAR ® film) having a conductive ink printed thereon to yield a pattern of conductive pads and interconnecting paths. Connection of a component to a set of the electrically conductive ink pads on the polymer thick-film circuit is accomplished either by soldering or by use of a conductive adhesive.

While polymer thick-film circuits are less expensive to fabricate than conventional FR-4 and polyester resin-based circuit boards, such thick-film circuits have not replaced conventional circuit boards in the fabrication of personal data cards. One reason why is that, heretofore, it has not been possible to make a reliable wire bond between each aluminum lead, associated with a semiconductor die, and an ink pad on a polymer thick-film circuit. Wire bonding is the preferred technique for reliably achieving an electrical connection between each semiconductor die and the interconnection media in fabricating a personal data card because of the fine pitch of the aluminum leads associated with the die.

Further, with present-day polymer thick-film circuits, the conductive pads and interconnecting paths, created by depositing conductive ink onto the polymer film, have an impedance which is thought to be suitable only for dc circuits found in contact-type personal data cards. As their name implies, contact-type cards have a set of electrical contacts designed for physical mating with a corresponding set of contacts on a corresponding card reader, thus allowing dc to be coupled t the card

directly to power the active components on the card. On the other hand, the impedance of the conductive ink paths and interconnecting pads on current-day polymer thick-film circuits is generally regarded as being too high for ac circuits found in contactless personal data cards. Contactless personal data cards are characterized by an absence of any contacts for physically making connection to a card reader. Instead, present-day contactless cards generally are provided with inductive and/or capacitive coupling means for coupling signals and power to the card. As may be appreciated, with contactless-type personal data cards, the dc needed to power active components on the card must be generated on the card itself from the ac coupled thereto. Hence, contactless cards carry one or more ac circuits not found on contact-type cards.

SUMMARY OF THE INVENTION

Briefly, in accordance with the invention there is disclosed a personal data card, typically of the contactless variety, which is fabricated from a polymer thick-film circuit. The polymer thick-film circuit is comprised of a sheet of polymer film on which a copper-loaded polymer ink is deposited to establish a pattern of electrically conductive pads and interconnecting conductive paths. Nickel is applied, typically by electroless plating, to selected pads on the thick-film circuit before such pads are plated with gold. The gold on each selectively plated pad facilitates wire bonding of an aluminum lead, associated with a semiconductor die, to the polymer thick-film circuit, while the nickel underlying the gold imparts enough rigidity to the gold to assure sufficient deformation of the lead for reliable bonding. The copper-loaded polymer ink deposited on the thick-film circuit yields a circuit having a sufficiently low impedance for ac circuits generally found on a contactless card. Moreover, the resistance of the ink was found to be lowered when the polymer thick-film circuit was laminated to other layers during subsequent fabrication of the personal data card, thus improving the card's electrical performance.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view of a contactless personal data card constructed in accordance with the present invention; and

FIG. 2 is a cross-sectional view of the personal data card of FIG. 1 taken along the plane 2—2 thereof.

DETAILED DESCRIPTION

FIG. 1 is a perspective of a contactless-type personal data card **10** constructed in accordance with the present invention. The card **10** is fabricated from a polymer thick-film circuit **12** comprised of a sheet **14** of polymer film (e.g., MYLAR ® film) approximately 1–2 mils thick. The actual thickness of the sheet **14** has been exaggerated for purposes of illustration. A pattern of pads **16** and **17** and interconnecting paths **18** is printed on the film **14** using a copper-filled polymer ink so that the pads and connecting paths, upon curing, are electrically conductive. Typically, the pads **16** and **17** and the paths **18** are printed so as to be approximately 1 mil thick, which renders them sufficiently conductive for carrying both dc and ac current with acceptable losses.

The pads **16** are relatively small in size (typically 50×50 mils) and serve as bond sites for leads associated with a semiconductive die, as well as for leads of dis-

crete passive components, as will be discussed hereinafter. For this reason, the pads **16** will hereinafter be referred to as "bond-site" pads. The pads **17** are made large (up to 0.375"×0.375") so that two or more can serve as capacitive plates for coupling data to the card **10** while others serve to seat a separate one of a plurality of semiconductor dies **19** which are typically secured to the film **14** by an adhesive. Typically, one of the dies **19** comprises a combined microprocessor and memory device while another die comprises an analog device for controlling signal flow, and for supplying dc power to the microprocessor and memory device.

Referring to FIG. **2**, each die **19** has a plurality of contacts **20** (only one shown) on its upper surface, each contact being electrically wire bonded to one end of an aluminum lead **21** whose opposite end is wire bonded to a corresponding bond-site pad **16**. To facilitate a wire bond between each aluminum lead **21** and a corresponding bond-site pad **16** on the polymer sheet **14**, each such bond-site pad has a layer **22** of nickel, approximately 300 microns thick, applied thereto. Typically, the layer **22** of nickel is applied by electroless plating. Above the nickel layer **22** is a layer **24** of gold approximately 10–20 μm thick, which is also typically applied by electroless plating.

The gold layer **24** serves as the medium to which the aluminum lead **21** is bonded. However, when the gold layer **24** was applied directly to a bond-site pad **16**, applicants discovered that the gold layer was simply too soft to sufficiently deform the aluminum lead **21** to effect a reliable bond. By applying the nickel layer **22** to the bond-site **16** below the gold layer **24**, the nickel, which is far harder, and is plated far thicker than the gold layer, acts to make the latter "infinitely" thick. In this way, the gold layer **24** is rendered sufficiently hard to deform the aluminum lead **21** bonded to it to effect a reliable bond.

In addition to the semiconductor dies **19**, the personal data card **10** further comprises a coil **26** which may take the form of a flexible, wound inductive device, as described in U.S. Pat. No. 4,692,604, issued in the name of R. L. Billings, and assigned to AT&T Bell Labs, or a disc coil. Typically, the coil **26** is secured to the film **14** by way of double-sided tape or an adhesive. An electrical connection between each of a pair of leads **27** of the coil **26** and each of a pair of bond-site pads **16** may be made via solder or via a conductive adhesive. The coil **26** serves as a secondary of a transformer to couple ac into the card **10** from a primary coil (not shown) placed in proximity thereto. The primary coil would typically reside in a card reader/writer device (not shown). Although not shown, the card **10** may further include one or more discrete passive components, i.e., a capacitor, bonded to the film **14** by an electrically conductive adhesive.

The polymer sheet **14** is made stiff by laminating a stiffening layer **28** (only a portion of which is shown) to the upper major surface of the film **14**. The stiffening layer **28** is typically made from a polyester resin and is provided with individual cutouts (not shown) to accommodate each of the semiconductor dies **19** and the coil **26** as well as any discrete components. In practice, the stiffening layer **28** is laminated to the film **14** prior to the attachment of the dies **19**, the coil **26**, and any discrete components to the film. Once the stiffening layer **28** is laminated to the film **14**, and the dies **19**, the coil **26**, and the discrete components are attached and electrically connected, a quantity of epoxy potting compound (not shown) is admitted into each of the cutouts in the stiffening layer **28**.

The epoxy is then cured, and thereafter, front and back labels **30** and **32** are laminated to the upper major surface of the stiffening layer **28** and to the bottom surface of the film **14**, respectively, thus completing the fabrication of the personal data card **10**. An advantage of fabricating the personal data card **10** in this fashion is that by laminating the layer **28** and the labels **30** and **32** to the film **14**, the pads **16** and **17** and the paths **18** are compressed, which further reduces their impedance, which is very desirable.

The foregoing describes a personal data card **10** fabricated from a polymer thick-film circuit **12** comprised of a film **14** patterned with copper-filled polymer ink which is selectively plated with nickel and then gold to advantageously facilitate wire bonding of semiconductor dies **19** thereto.

It is to be understood that the above-described embodiments are merely illustrative of the principles of the invention. Various modifications and changes may be made thereto by those skilled in the art which will embody the principles of the invention and fall within the spirit and scope thereof.

We claim:

1. A method for fabricating a personal card comprising the steps of:

forming a polymer thick-film circuit by printing a pattern of conductive pads and interconnecting paths on a polymer film with a conductive ink;

applying a layer of nickel to selected pads on the film;

applying a layer of gold above the nickel layer on said selected pads;

wire bonding each of a plurality of leads associated with at least one semiconductor die to a corresponding one of said selected pads to which nickel and then gold is applied; and

laminating at least one additional layer to the film.

2. The method according to claim **1** wherein the nickel is applied to said selected pads by electroless plating.

3. The method according to claim **1** wherein the gold is applied to the nickel on said selected pads by electroless plating.

4. The method according to claim **1** wherein a stiffening layer is laminated to a first surface of the polymer film and a front and back label are each laminated to the stiffening layer and to the film, respectively.

5. The method according to claim **1** further including the step of attaching a coil to the film and connecting each of the pair of leads of the coil to a corresponding one of a pair of conductive pads on the film.

6. A personal data card fabricated by the steps of:

forming a polymer thick-film circuit by printing a pattern of conductive pads and interconnecting paths on a polymer film with a conductive ink;

applying a layer of nickel to selected pads on the film;

applying a layer of gold above the nickel layer on said selected pads;

wire bonding each of a plurality of leads associated with at least one semiconductor die to a corresponding one of said selected pads to which nickel and then gold is applied; and

laminating at least one additional layer to the film.

7. The data card according to claim **1** wherein the nickel is applied to said selected pads by electroless plating.

8. The data card according to claim 6 wherein the gold is applied to the nickel on said selected pads by electroless plating.

9. The data card according to claim 6 wherein a stiffening layer is laminated to a first surface of the polymer film, and front and back labels are each laminated to the stiffening layer and to the film, respectively.

10. A personal data card comprising:

a polymer thick-film circuit formed of a sheet of polymer film having a pattern of pads and interconnecting paths printed thereon with a conductive ink, each of a plurality of selected pads having a layer of nickel applied thereto and a layer of gold overlying the layer of nickel.

at least one semiconductor die having a plurality of contacts each wire bonded by a lead to a corresponding one of said selected pads having nickel and then gold applied thereto; and

at least one additional layer laminated to the polymer thick-film circuit.

11. The personal data card according to claim 10 wherein conductive ink printed on the polymer film comprises a copper-loaded polymer ink.

12. The personal data card according to claim 10 further including a coil attached to the polymer film for coupling ac into the card.

13. The personal data card according to claim 10 further including a stiffening layer laminated to a first surface of the polymer film and front and back labels laminated to the stiffening layer and to the opposite surface of the film, respectively.

* * * * *

US005396650A

United States Patent [19]

Terauchi

[11] Patent Number: 5,396,650

[45] Date of Patent: Mar. 7, 1995

[54] **WIRELESS COMMUNICATION DEVICE WITH MULTI-FUNCTION INTEGRATED CIRCUIT PROCESSING CARD**

[75] Inventor: **Tohru Terauchi**, Hyogo, Japan

[73] Assignee: **Mitsubishi Denki Kabushiki Kaisha**, Tokyo, Japan

[21] Appl. No.: **913,630**

[22] Filed: **Jul. 16, 1992**

[30] **Foreign Application Priority Data**

Jul. 22, 1991 [JP] Japan 3-204579

[51] **Int. Cl.**[6] **H04Q 3/02**

[52] **U.S. Cl.** **455/38.2**; 455/38.4; 455/344; 340/825.44

[58] **Field of Search** 455/38.1, 38.2, 38.4, 455/89-90, 344, 74; 340/825.22, 825.54, 825.44; 379/357, 144

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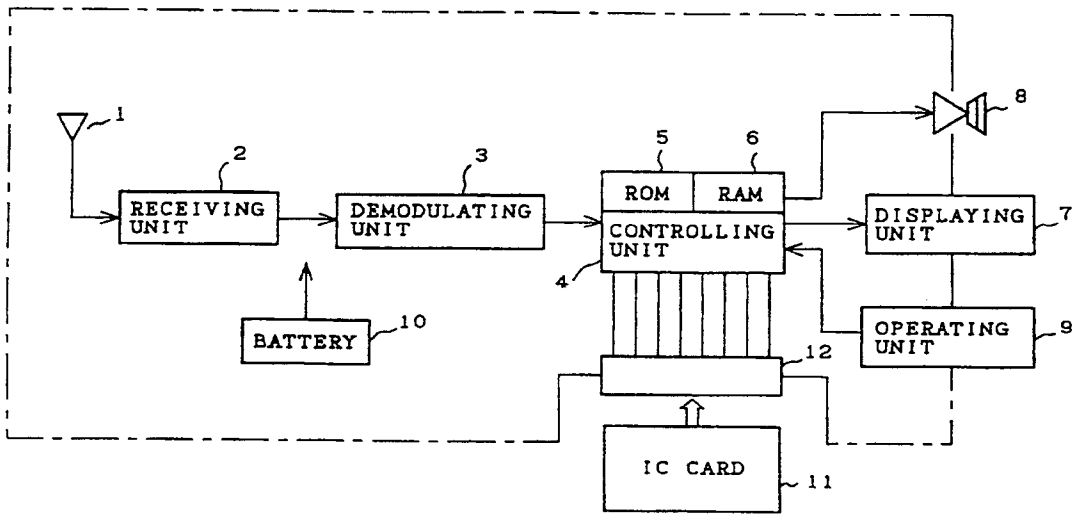
Primary Examiner—Edward F. Urban
Assistant Examiner—Andrew Faile
Attorney, Agent, or Firm—Rothwell, Figg, Ernst & Kurz

[57] **ABSTRACT**

Disclosed herein is a wireless device of the present invention, of a type wherein an external connecting terminal for electrically connecting an IC card having a function for processing various applications is disposed so as to be electrically connected to a controlling unit for carrying out the entire control of the wireless device. The controlling unit for performing the entire control of the wireless device can be replaced by an IC card having a function for carrying out the entire control of the wireless device.

3 Claims, 6 Drawing Sheets



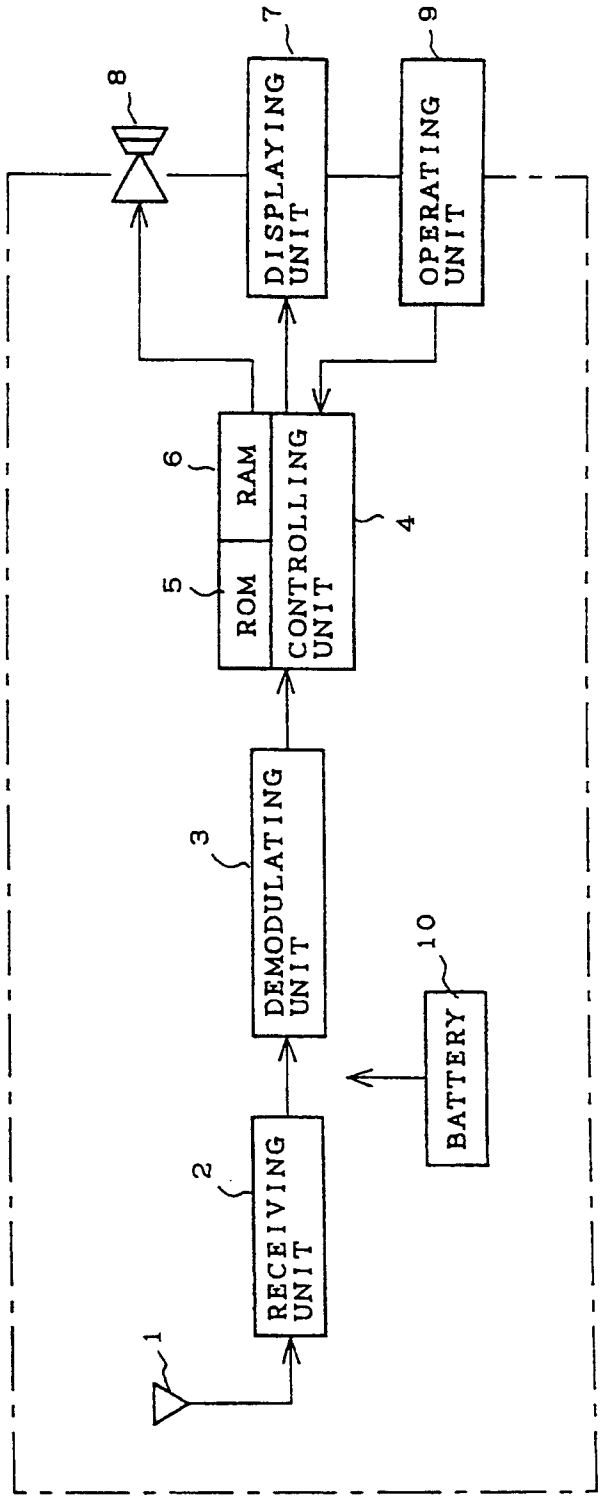
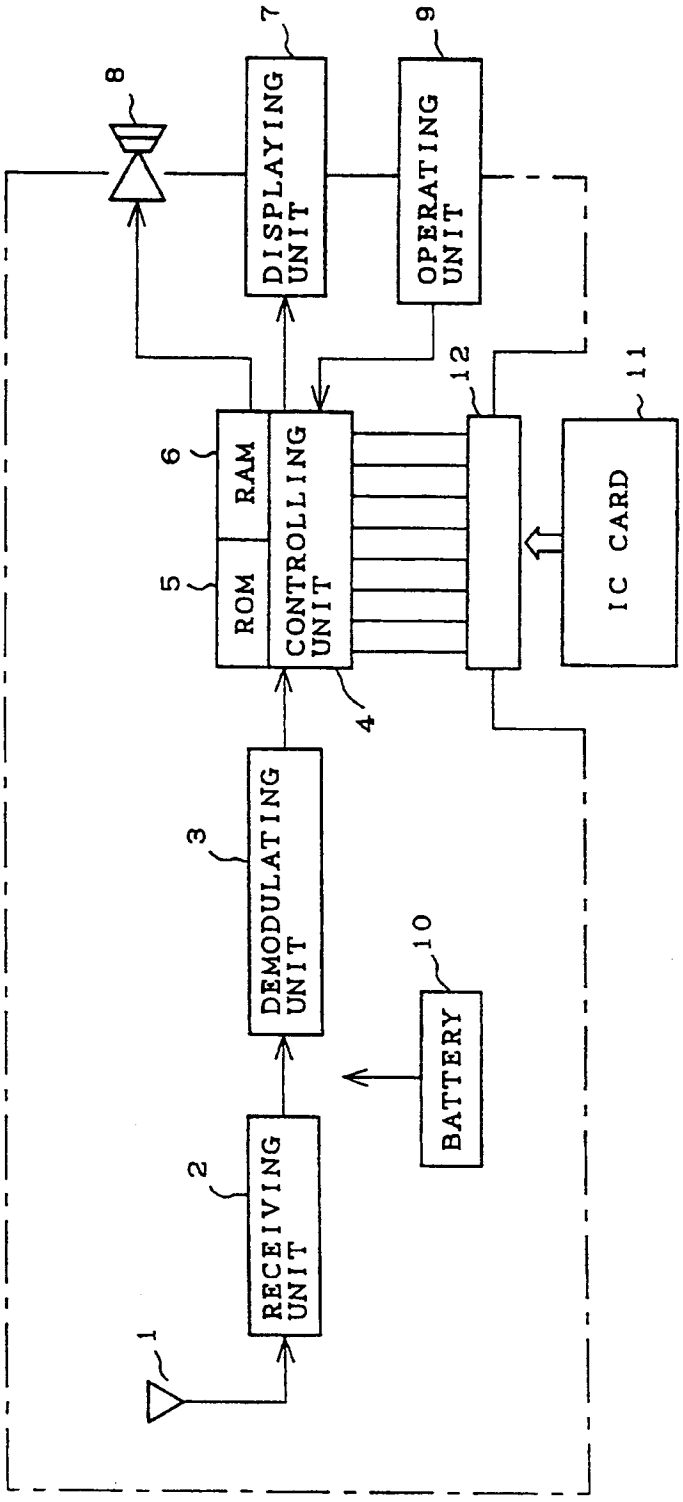


FIG. 1 (PRIOR ART)

FIG. 2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4
CONTROLLING UNIT
5
ROM
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RAM
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DISPLAYING UNIT
8
9
OPERATING UNIT
10
BATTERY
11
IC CARD
12

FIG. 3

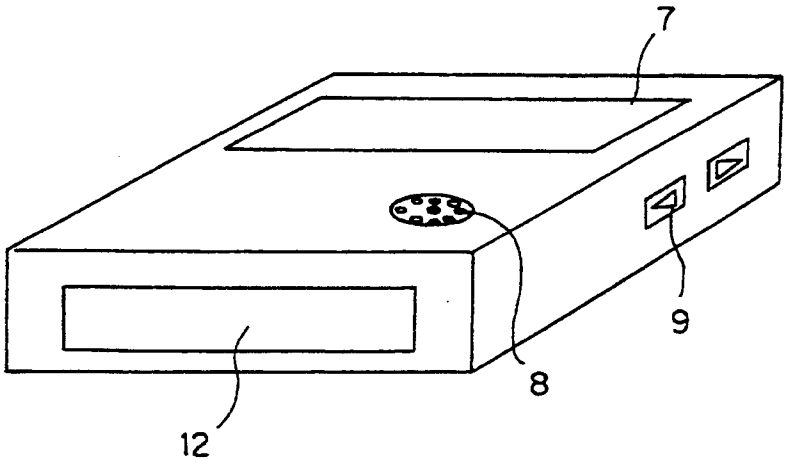


FIG. 5

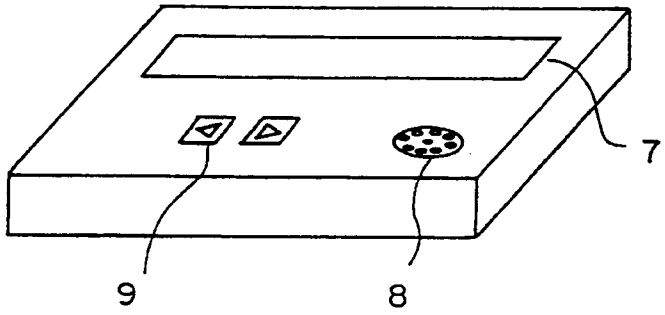


FIG. 6

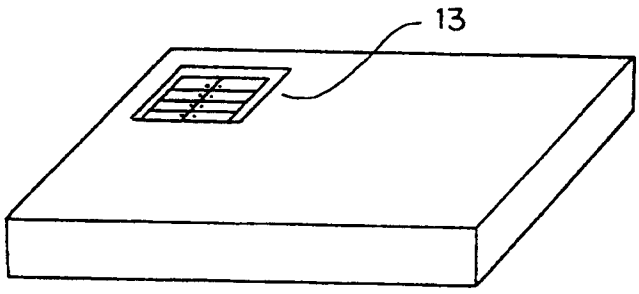
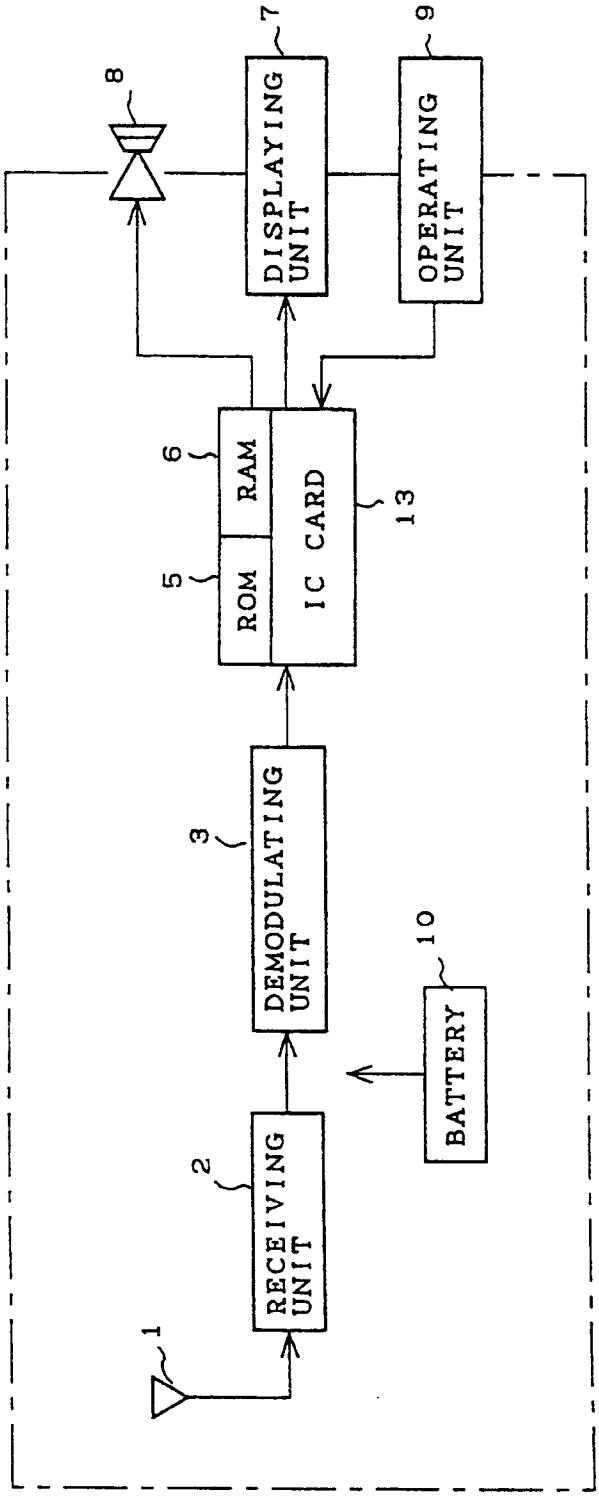


FIG. 4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ANTENNA
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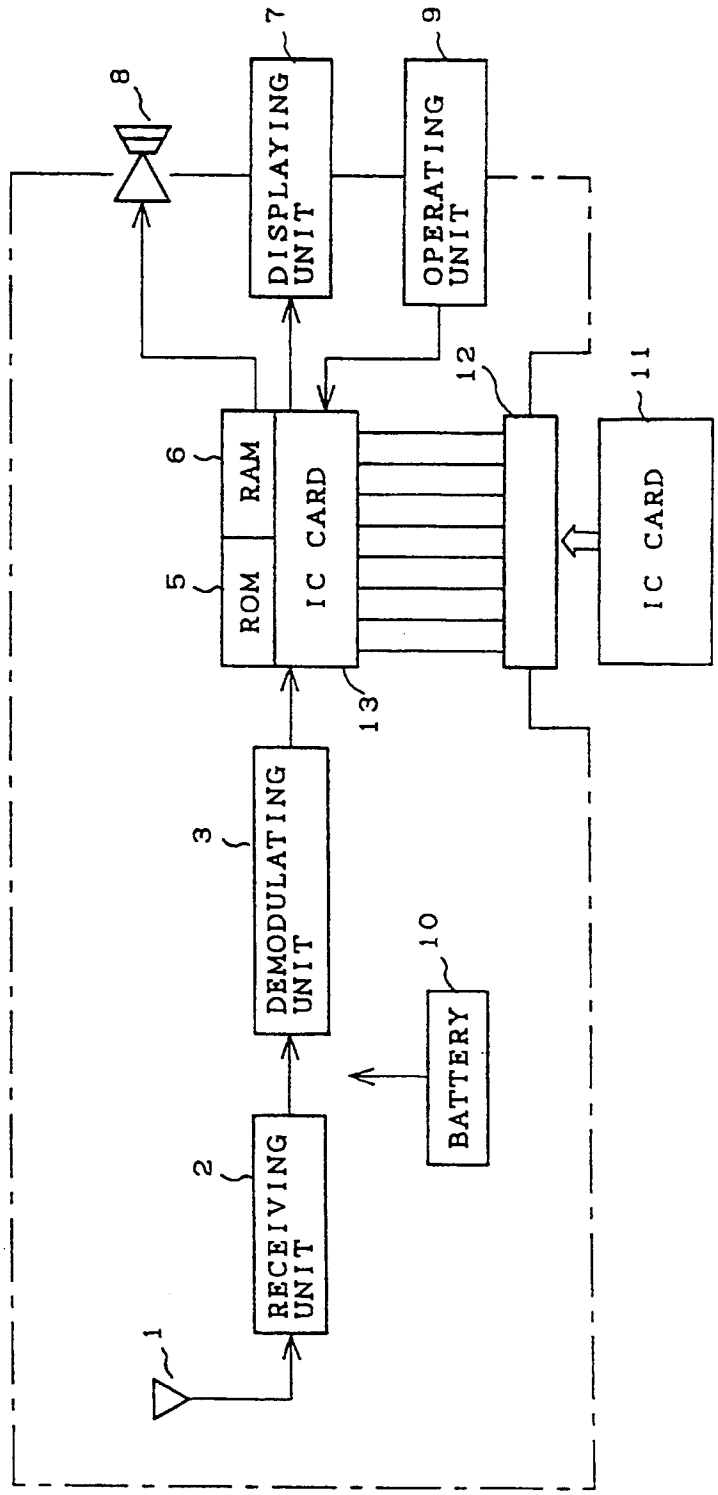
9
OPERATING UNIT
10
BATTERY

FIG. 7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ROM
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IC CARD
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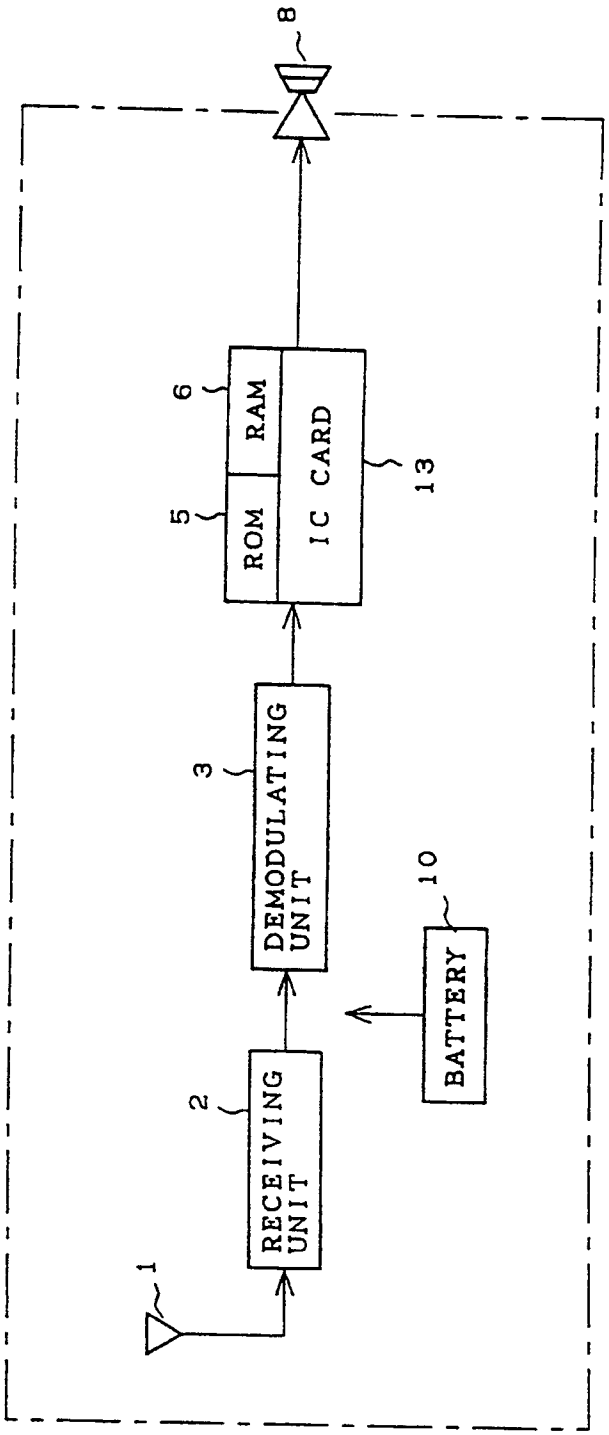
10
BATTERY
2
RECEIVING UNIT
1

FIG. 8


8
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IC CARD
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1

WIRELESS COMMUNICATION DEVICE WITH MULTI-FUNCTION INTEGRATED CIRCUIT PROCESSING CARD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a wireless device such as a pocket bell for making a wireless call, and particularly to an improvement in the extension of a wireless calling function.

2. Description of the Prior Art

FIG. 1 is a block diagram showing a radio receiving set, i.e., a wireless device such as a conventional typical pocket bell, for making a wireless call. In the same drawing, there are shown an antenna 1 for receiving an incoming radio wave, a receiving unit 2 for analyzing the radio wave received by the antenna 1, and a demodulating unit 3 for demodulating the radio wave analyzed by the receiving unit 2 and converting it into information required for control of the wireless device.

Reference numeral 4 indicates a controlling unit for electrically processing the information thus converted and performing the entire control of the wireless device. Reference numeral 5 indicates a read-only memory (hereinafter called a "ROM") having software stored therein for causing the controlling unit 4 to effect a predetermined operation. In addition, designated at numeral 6 is a random-access memory (hereinafter called a "RAM") for causing the controlling unit 4 to record necessary data therein during its control operation.

Reference numeral 7 indicates a displaying unit for displaying given characters and symbols such as messages thereon under the control of the controlling unit 4. Reference numeral 8 indicates a tone generating unit for generating a calling tone used to give notice of a call to a user upon arrival of the call under the control of the controlling unit 4 in the same manner as described above. In addition, reference numeral 9 indicates an operating unit for inputting a signal for control such as a message retrieval to the controlling unit 4, and reference numeral 10 indicates a battery for supplying electric power to the wireless device.

The operation of the conventional wireless device will now be described. The antenna 1 receives an incoming radio wave and transfers it to the receiving unit 2. The receiving unit 2 analyzes the received radio wave and sends it to the demodulating unit 3. Afterwards, the demodulating unit 3 demodulates the radio wave analyzed by the receiving unit 2 and converts it into information required for control, followed by transfer to the controlling unit 4.

The controlling unit 4 compares "Identification" in the information converted by the demodulating unit 3 with "Identification" of the wireless device. If they coincide with each other, then the controlling unit 4 takes in the information converted by the demodulating unit 3. Next, the controlling unit 4 processes this information on the basis of the software stored in the ROM 5. Afterward, the controlling unit 4 energizes the tone generating unit 8 to produce a calling tone and display a message on the displaying unit 7 if the message is given.

For example, Japanese Patent Application Laid-Open No. 2-190036 is disclosed as a reference in which a technique relative to the conventional wireless device referred to above has been described.

Since the conventional wireless device is constructed as described above, it simply has a function for generating a calling tone and a function for displaying a message upon reception of the radio wave. With an increase in diversification of radio communications, the terms "whenever, wherever and whomever" are common to users. Thus, the conventional wireless device cannot meet present-day needs in terms of an increase in terminals having a plurality of pieces of additive value.

SUMMARY OF THE INVENTION

With the foregoing problems in view, it is an object of the present invention to provide a wireless device capable of providing a multifunctional service.

It is another object of the present invention to provide a wireless device capable of performing the calculation based on a desk calculating function and the retrieval of a telephone number based on a telephone-book retrieving function.

It is a further object of the present invention to provide a wireless device to which a calling tone can be automatically sent from a telephone terminal or the like.

It is a still further object of the present invention to provide a wireless device which can be designed in a small size and reduced in cost while providing performance superior to that of a conventional wireless device.

According to a first aspect of a wireless device of the present invention, an external connecting terminal for connecting an IC card having a function for processing various applications is mounted to a controlling unit for performing the entire control of the wireless device in order to achieve the above objects.

Further, according to a second aspect of a wireless device of the present invention, a controlling unit for carrying out the entire control of the wireless device is replaced by an IC card having a function for performing the entire control of the wireless device in order to achieve the above objects.

Furthermore, according to a third aspect of a wireless device of the present invention, a controlling unit for performing the entire control of the wireless device is replaced by an IC card having a function for effecting the entire control of the wireless device, and both a displaying unit and an operating unit are omitted, in order to achieve the above objects.

That is, a controlling unit employed in a wireless device of the present invention makes use of an application processing function of an IC card connected via an external connecting terminal to the controlling unit. It is therefore possible to provide a wireless device capable of carrying out calculations based on a desk calculating function and the retrieval of a telephone number based on a telephone-book retrieving function. In addition, the IC card used as an alternative to the controlling unit of the wireless device of the present invention performs the entire control of the wireless device. Therefore, a wireless device to which a calling tone can be automatically made from a telephone terminal or the like, can be realized by making use of information such as a message obtained upon control of the wireless device by the IC card.

The above and other objects, features and advantages of the present invention will become apparent from the following description and the appended claims, taken in conjunction with the accompanying drawings. How-

ever, the accompanying drawings are simply used for illustration and do not limit the scope of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing a conventional wireless device;

FIG. 2 is a block diagram illustrating a wireless device according to a first embodiment of the present invention;

FIG. 3 is a perspective view depicting the exterior of the wireless device shown in FIG. 2;

FIG. 4 is a block diagram showing a wireless device according to a second embodiment of the present invention;

FIG. 5 is a perspective view depicting the exterior of the wireless device shown in FIG. 4 as seen from the top face thereof;

FIG. 6 is a perspective view illustrating the exterior of the wireless device of FIG. 4 as seen from the bottom face thereof;

FIG. 7 is a block diagram showing a wireless device according to a third embodiment of the present invention; and

FIG. 8 is a block diagram depicting a wireless device according to a fourth embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention will hereinafter be described in detail with reference to the accompanying drawings.

First embodiment

FIG. 2 is a block diagram showing a radio receiving set, i.e., a radio or wireless device according to a first embodiment of the present invention. FIG. 3 is a perspective view of the exterior of the wireless device shown in FIG. 2. In the same drawing, there are shown an antenna 1, a receiving unit 2, a demodulating unit 3, a controlling unit 4, a ROM 5, a RAM 6, a displaying unit 7, a tone generating unit 8, an operating unit 9, and a battery 10. The components of the wireless device shown in FIG. 2 are identical or equivalent to those denoted by identical reference numerals in FIG. 1 and their detailed description will therefore be omitted.

Reference numeral 11 indicates an IC card having a function for processing various applications such as an electronic desk calculating function, a telephone-book retrieving function, etc., whereas reference numeral 12 indicates an external connecting terminal used to connect the IC card 11 to the controlling unit 4.

Incidentally, the operating unit 9 has a function for selecting any one of various applications of the IC card 11. The battery 10 is used to supply electric power to the IC card 11.

The operation of the wireless device will now be described. Incidentally, a wireless calling operation is identical to that of a conventional wireless device and its description will therefore be omitted. A description will be made principally of an application process using the IC card 11.

When a desired application is selected by a user who makes use of the wireless device, the IC card 11 having a function for processing the application is first inserted into the external connecting terminal 12. Then, the controlling unit 4 to which the IC card 11 has been connected via the external connecting terminal 12 displays various functions on the displaying unit 7 for processing different applications borne by the IC card 11.

The user controls the operating unit 9 while referring to the various functions displayed on the displaying unit 7 so as to select an intended application, thereby setting an operation mode to a process for the thus-selected application. When the selected application represents a desk calculating function, a desired calculation can be performed by the operating unit 9. When the selected application represents a telephone-book retrieving function, a desired telephone number can be retrieved by the operating unit 9.

Incidentally, the IC card 11 can be detachably mounted to the controlling unit 4 via the external connecting terminal 12. Therefore, the IC card 11 having various applications can be used, thereby making it possible to achieve a wireless device which can easily process various functions other than the wireless calling function and provide high additive value.

Second embodiment

FIG. 4 is a block diagram showing a wireless device according to a second embodiment of the present invention. FIG. 5 is a perspective view showing the above wireless device as seen from the top face thereof. FIG. 6 is a perspective view illustrating the above wireless device as seen from the bottom face thereof. The same elements of structure as those employed in each of the wireless devices shown in FIGS. 2 and 3 are identified by like reference numerals and the description of certain common elements will therefore be omitted.

In FIG. 4, reference numeral 13 indicates an IC card provided as an alternative to the controlling unit 4. The IC card 13 has a function for performing the entire control of the wireless device of a type wherein a wireless call is made based on information converted in the demodulating unit 3.

The operation of the wireless device will now be described. A radio wave received by the antenna 1 is analyzed by the receiving unit 2. Then, the radio wave thus analyzed is demodulated and converted into information required to control the wireless device by the demodulating unit 3, followed by transfer to the IC card 13. Afterwards, the IC card 13 detects that Identification in the converted information has coincided with Identification of the wireless device and takes in information about the result of detection, thereby generating a ringing or calling tone from the tone generating unit 8 or displaying messages on a displaying unit.

The IC card 13 has already stored therein a message received at the time of the wireless calling process. A wireless call can also be automatically sent to a corresponding called party based on a code included in the message stored therein.

That is, when a mechanism for holding the IC card 13 is mounted to a telephone terminal and the IC card 13 with the received message stored therein is inserted into the mechanism, information about the telephone number of the corresponding called party is automatically produced based on the code included in the message and a wireless call based on that information is automatically made from the telephone terminal.

Third embodiment

The above embodiments are directed to a case in which the conventional controlling unit 4 has been

replaced by the IC card 13. However, an external connecting terminal 12 may be provided for electrically connecting an IC card 11 having a function for processing applications to the IC card 13 may be disposed. By inserting the IC card 11 into the connecting terminal 12, a wireless device capable of providing a function for processing various applications as well as the functions employed in the embodiments shown in FIGS. 4 through 6, can be realized.

Fourth embodiment

FIG. 8 is a block diagram showing a wireless device according to a fourth embodiment of the present invention. Reference numerals employed in FIG. 8 are identical or equivalent to those shown in FIG. 4.

In the present embodiment, the displaying unit 7 and the operating unit 9 are not provided. When a user who has recognized a wireless call from a calling tone generated by the tone generating unit 8 inserts the IC card 13 into an additionally-provided terminal or the like, the IC card 13 having the wireless calling function is activated.

According to a first aspect of a wireless device of the present invention, as described above, an external connecting terminal for connecting an IC card having a function for processing applications is provided so as to be connected to a controlling unit for performing the overall control of the wireless device. Therefore, the calculation based on a desk calculating function and the retrieval of a telephone number based on a telephone-book retrieving function can be performed by making use of the application processing function of the IC card connected via the external connecting terminal to the controlling unit, thereby making it possible to provide a wireless device which can meet various functions other than a wireless calling function and provide high additive value.

Further, according to a second aspect of a wireless device of the present invention, a controlling unit for performing the overall control of the wireless device is replaced by an IC card having a wireless calling function. Therefore, a wireless call or the like can be automatically made from a telephone terminal or the like by making use of a message or the like produced when the IC card is used as an alternative to the controlling unit and performs a wireless calling process, thereby making it possible to provide the wireless device which can meet a variety of functions other than a wireless calling function and provide high additive value.

Furthermore, according to a third aspect of a wireless device of the present invention, a controlling unit is replaced by an IC card having a wireless calling function. The wireless device is not provided with a displaying unit and an operating unit. Therefore, a wireless call can be automatically made from a telephone terminal or the like by making use of a message or the like obtained when the wireless call has been made. It is thus possible to provide a wireless device capable of meeting various functions other than a wireless calling function, providing high additive value, and achieving a further reduction in size and cost.

Having now fully described the invention, it will be apparent to those skilled in the art that many changes and modifications can be made without departing from the spirit or scope of the invention as set forth herein.

What is claimed is:

1. A mobile wireless communication device having multiple selectable functions, comprising:

a receiving unit for analyzing a modulated radio wave received by an antenna;

a demodulating unit for demodulating said analyzed modulated radio wave to derive a demodulated radio wave and for converting said demodulated radio wave into control information required for control of said wireless communication device;

a controlling unit for electrically processing said control information and performing the control of said wireless communication device in response to said control information;

a displaying unit for displaying predetermined characters and symbols thereon under the control of said controlling unit;

a tone generating unit for generating a calling tone under the control of said controlling unit;

an operating unit for inputting a controlling signal to said controlling unit;

an IC card having electronic processing functions; and

an external connecting terminal for electrically connecting said IC card to said controlling unit for connecting selected processing functions from said IC card to said controlling unit for processing selected applications through said controlling unit.

2. A mobile wireless communication device having multiple selectable functions, comprising:

a receiving unit for analyzing a modulated radio wave received by an antenna;

a demodulating unit for demodulating said analyzed modulated radio wave to derive a demodulated radio wave and for converting said demodulated radio wave into control information required for control of said wireless communication device;

an IC card having electronic processing functions and having a function for electrically processing said control information and performing the entire control of said wireless communication device;

a displaying unit for displaying predetermined characters and symbols thereon under the control of said IC card; and

a tone generating unit for generating a calling tone under the control of said IC card.

3. A mobile wireless communication device having multiple selectable functions, comprising:

a receiving unit for analyzing a modulated radio wave received by an antenna;

a demodulating unit for demodulating said analyzed modulated radio wave to derive a demodulated radio wave and for converting said demodulated radio wave into control information required for control of said wireless communication device;

an IC card having electronic processing functions and having a function for electrically processing said control information and performing the entire control of said wireless communication device; and

a tone generating unit for generating a calling tone under the control of said IC card.

* * * * *

US005412192A

United States Patent [19]

Hoss

[11] **Patent Number: 5,412,192**

[45] **Date of Patent: May 2, 1995**

[54] **RADIO FREQUENCY ACTIVATED CHARGE CARD**

[75] Inventor: **Robert J. Hoss**, Cave Creek, Ariz.

[73] Assignee: **American Express Company**, New York, N.Y.

[21] Appl. No.: **94,753**

[22] Filed: **Jul. 20, 1993**

[51] **Int. Cl.**[6] **G06K 19/067**; G08B 5/22

[52] **U.S. Cl.** **235/380**; 235/487; 340/825.44

[58] **Field of Search** 235/380, 382, 382.5, 235/435, 439, 449, 492; 340/825.54

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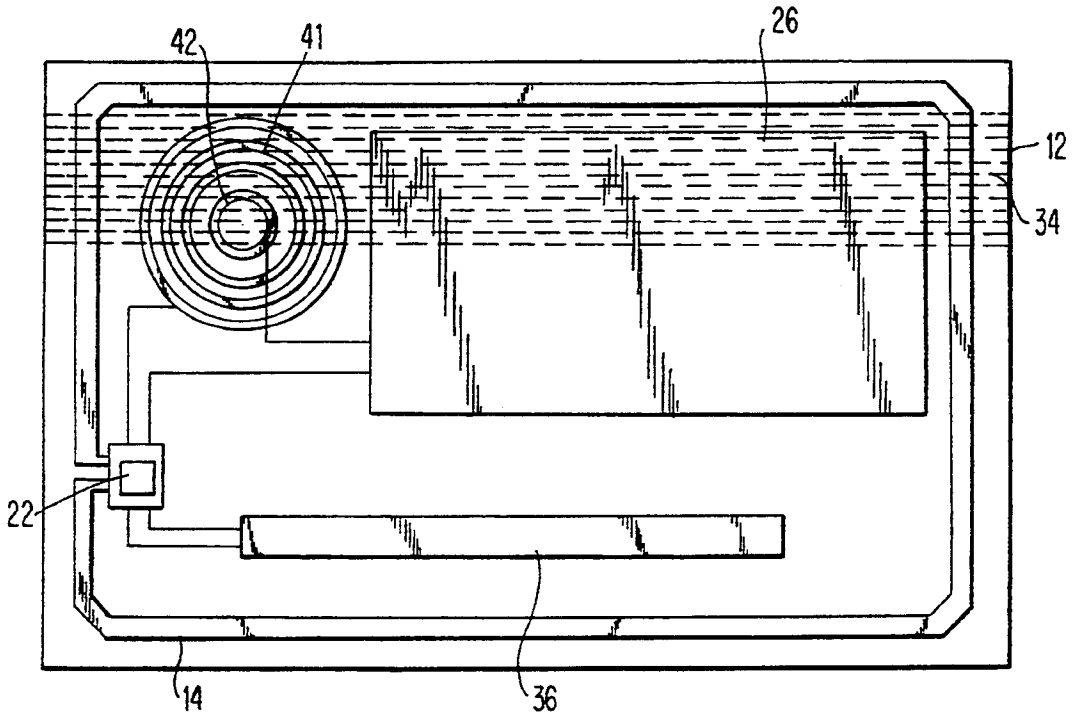
Primary Examiner—Donald Hajec
Assistant Examiner—Edward H. Sikorski
Attorney, Agent, or Firm—Snell & Wilmer

[57] **ABSTRACT**

A system for changing the activation status of a selected data card such as a charge card by broadcasting an appropriate RF signal. An antenna embedded in the card detects and decodes the signal, and operates a transducer which changes the card appearance, alters magnetic stripe information, or alters the information contained within the card.

1 Claim, 6 Drawing Sheets



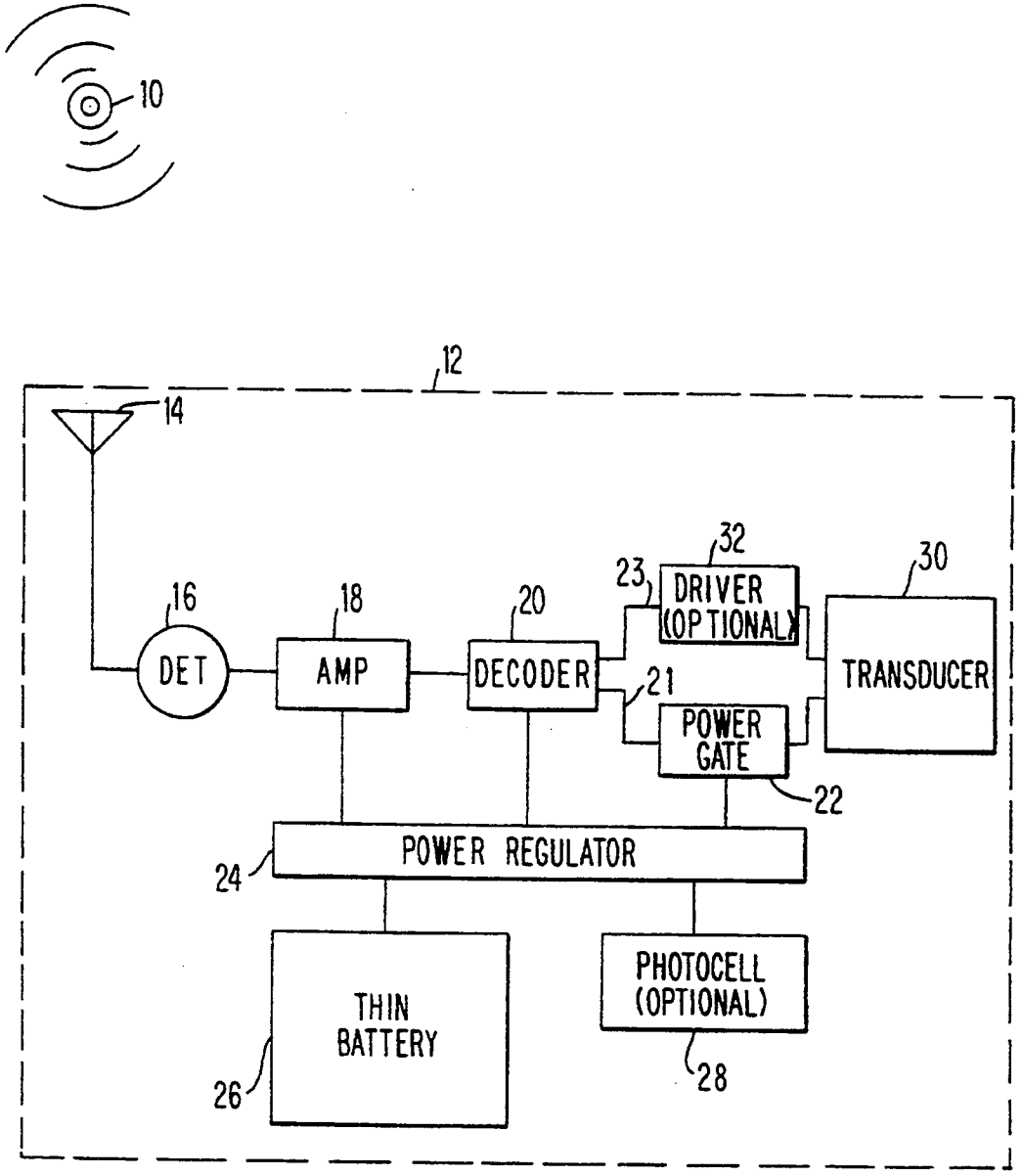

10
12
14
16
DET
18
AMP
20
DECODER
23
32
DRIVER
(OPTIONAL)
21
POWER
GATE
22
30
TRANSDUCER
24
POWER REGULATOR
26
THIN
BATTERY
PHOTOCELL
(OPTIONAL)
28

FIG. 1

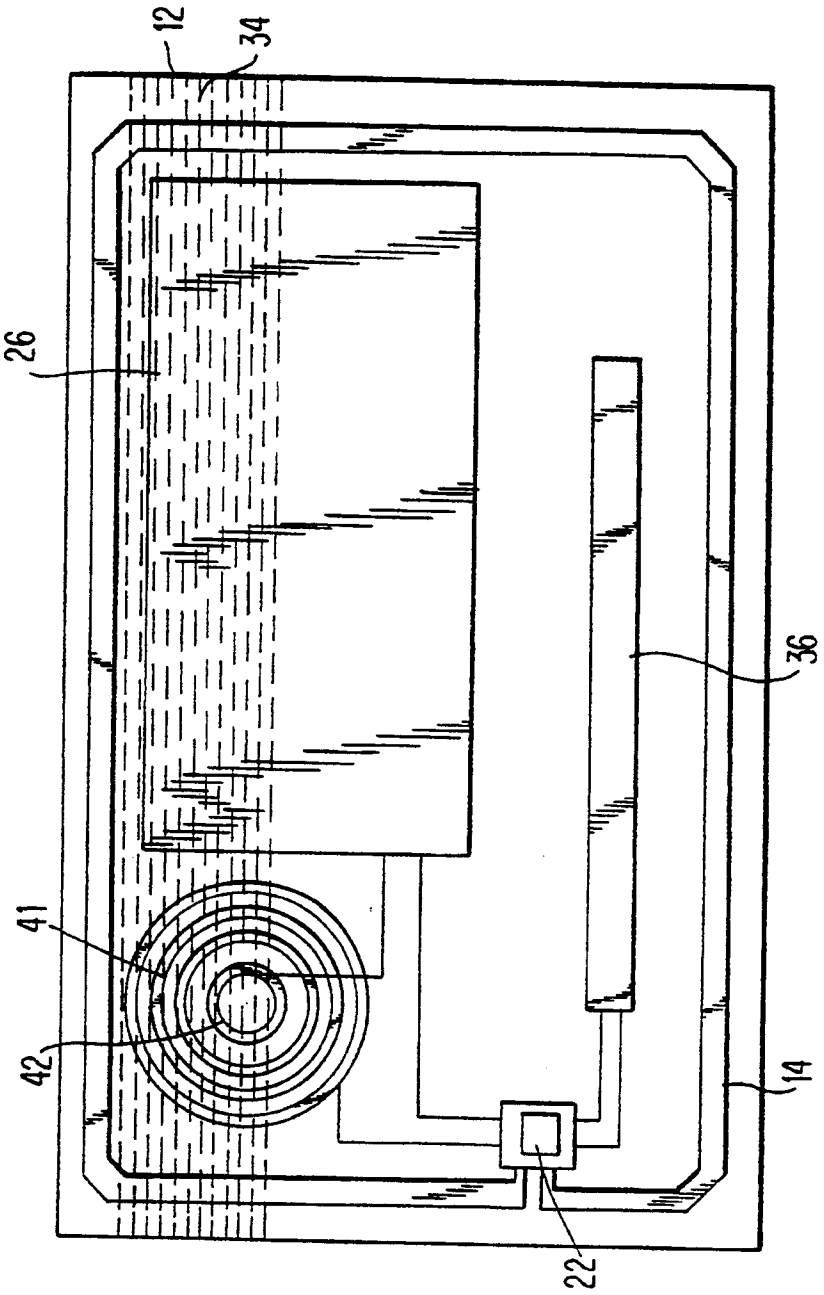


FIG. 2

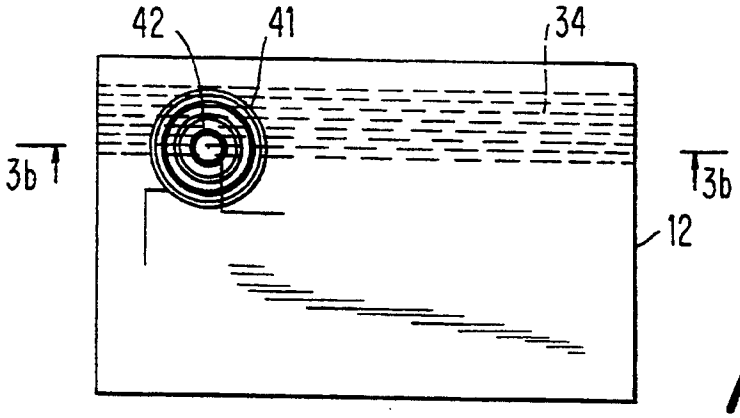


FIG. 3a

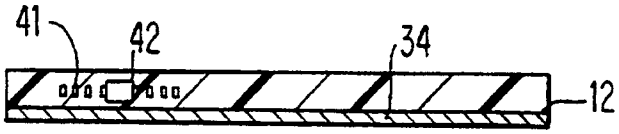


FIG. 3b

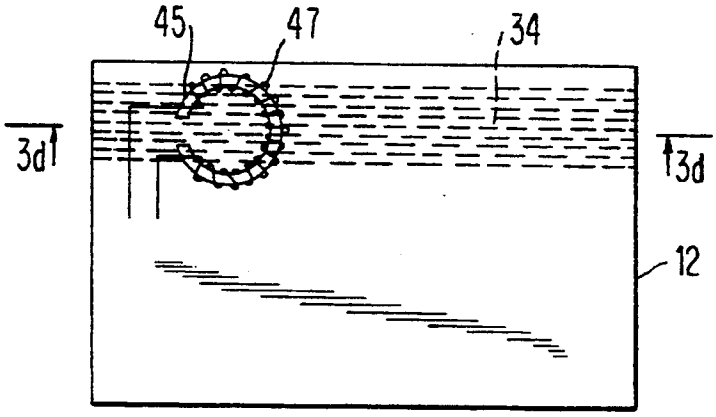
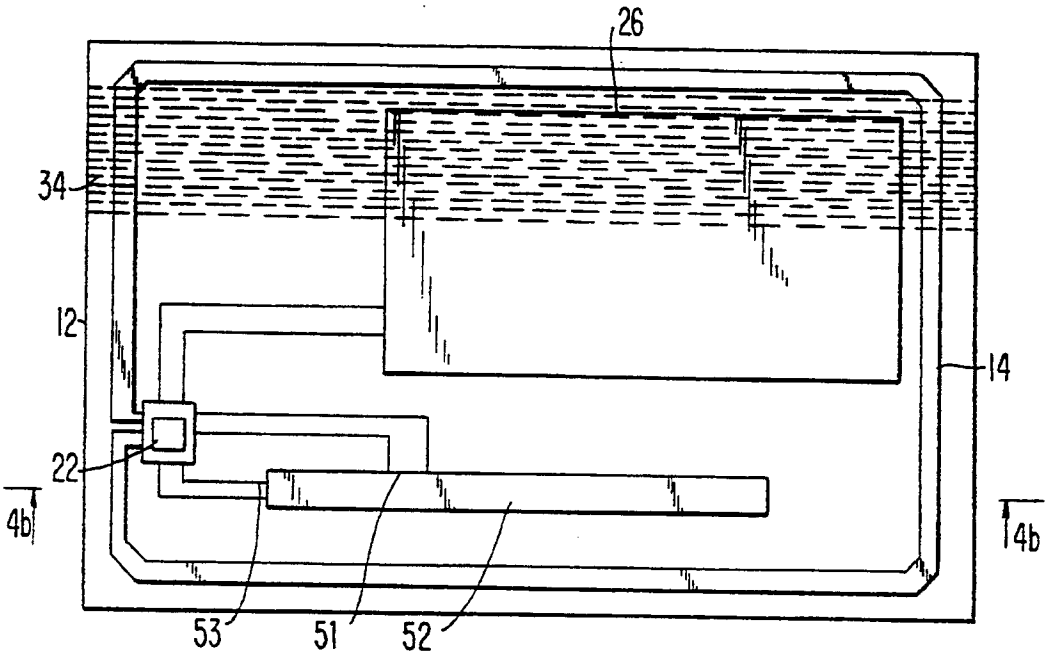


FIG. 3c

FIG. 3d

FIG. 4a



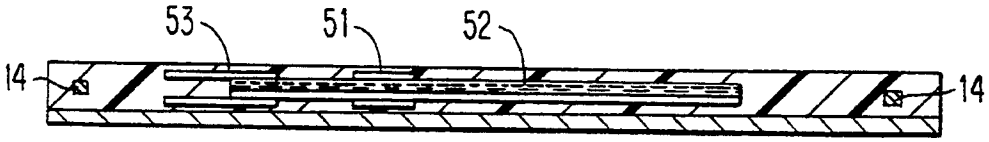
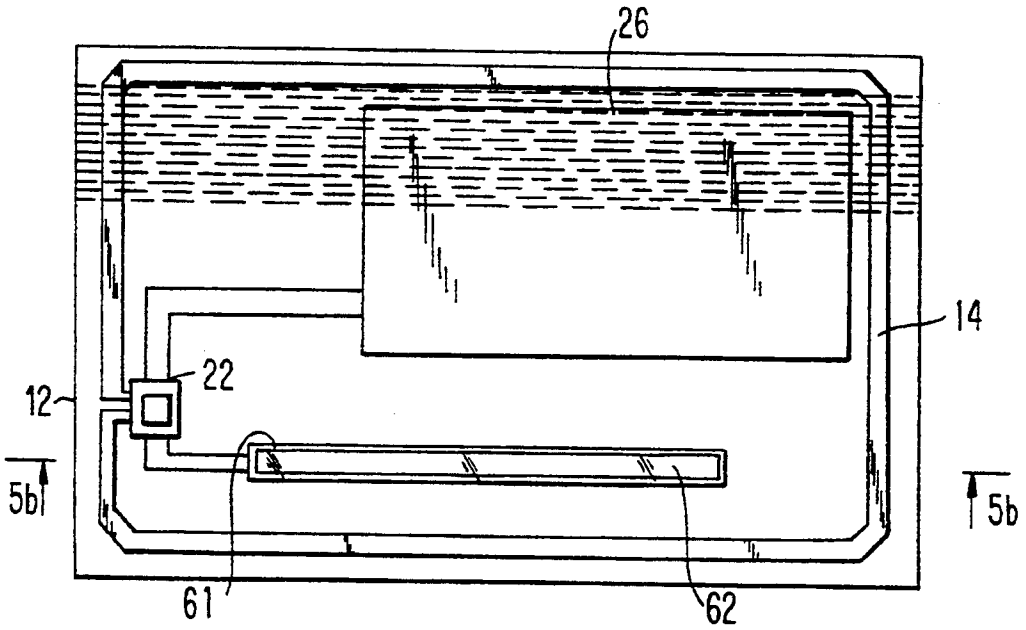


FIG. 4b

FIG.5a



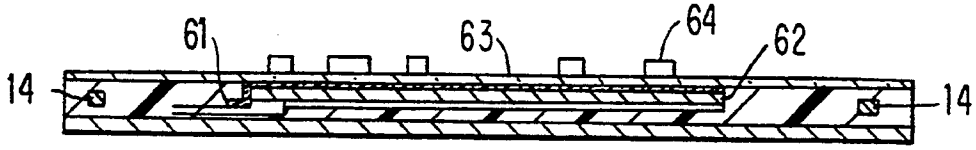
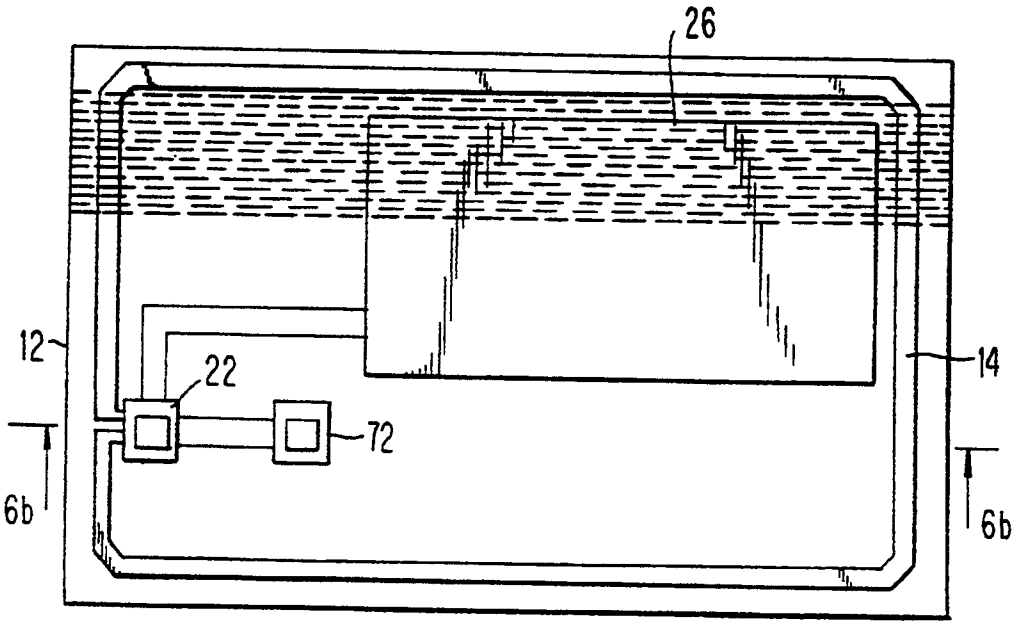


FIG.5b

FIG. 6a



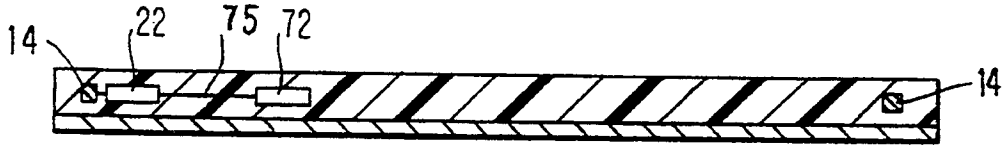


FIG. 6b

RADIO FREQUENCY ACTIVATED CHARGE CARD

TECHNICAL FIELD

This invention relates to charge (credit or debit) cards and, more particularly, to a data card whose size is that of a conventional charge card and which is remotely controllable by a broadcast signal.

BACKGROUND ART

It is known in the prior art to modify a data card, e.g., a charge card, when it is inserted in a terminal for data entry. However, until the cardholder actually uses the card, the information on and status of the card generally remain fixed.

This is true even of prior art memory cards which contain microelectronic circuitry for transferring information between the card and a data processing terminal, for example, U.S. Pat. No. 4,868,373 in the names of Opheig et al. Another prior art memory card is described in U.S. Pat. No. 4,795,898, in the names of Bernstein et al. This patent discloses a personal memory card which is the size of a standard plastic credit card and includes a processor, an electrically erasable field-programmable read-only memory, circuitry for inductively receiving a power signal, and circuitry for capacitively transferring data signals between the card and a card reader/writer located in an associated station. Again, the card must be brought in proximity of the card reader/writer for the transfer of status or activation information.

Paging systems provided in the prior art enable a user to detect a radio frequency (RF) or other broadcast signal, but are much larger than a charge card. Also, while they display a message, they do not contain transducers which permanently or temporarily change the actual status or validation of the device. Thus, although a message can be provided to the user of the paging system, the pager itself does not change its mode of operation upon receipt of a broadcast signal.

It is a primary object of the present invention to provide a new and improved data card whose status, information content and/or activation can be modified by a broadcast signal.

It is yet another object of the present invention to provide a new and improved data card for displaying a broadcast message.

Further objects, features and advantages of the invention will become apparent from the following description.

SUMMARY OF THE INVENTION

Briefly stated, and in accordance with one embodiment of the invention, a data card, whose shape is that of a conventional charge card, includes an on-board antenna for detecting an RF signal transmitted from a remote source, and responds to it by operating a transducer which in turn alters a characteristic of, or information contained within, the data card. (In general, changing a characteristic, e.g., the visual appearance of a card, or its activation, or its information content are referred to collectively as a change in status.) The transducer, for example, may discolor the card to indicate that it is no longer valid, or may change a bit in the magnetic stripe. The card may also respond by displaying some other kind of information, e.g., the telephone number of the closest regional service office of the card issuer. The card can be a standard contact or contactless "smart card" in which the information contained within the "smart" chip memory or the activation of the smart chip itself is controlled by an RF signal. Power for the card electronics can be derived from a flat battery within the card, or a solar cell, or even from an alternating magnetic field generated by a card reader.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be readily understood from the following detailed description, taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a block diagram of the components provided on a wallet-size data card of the present invention;

FIG. **2** is a schematic illustrating a physical realization of the block circuitry depicted in FIG. **1**;

FIG. **3***a* is a schematic illustration of an alternative embodiment of the present invention in which an electromagnetic field is created over a small region of a magnetic stripe on the card to alter the information provided therein;

FIG. **3***b* is a sectional view taken along line **3***b*—**3***b* of FIG. **3***a*;

FIG. **3***c* is a schematic illustration of another alternative embodiment of the present invention;

FIG. **3***d* is a sectional view taken along line **3***d*—**3***d* of FIG. **3***c*;

FIG. **4***a* is a schematic illustration of another embodiment of the present invention in which information on a liquid crystal display of a data card is altered;

FIG. **4***b* is a sectional view taken along line **4***b*—**4***b* of FIG. **4***a*;

FIG. **5***a* is a schematic illustration of yet another embodiment of the present invention in which an electrochemical compound is used to change the color of a portion of the card, or in which an electrochemical transducer generates heat to change the physical appearance of a heat-sensitive plastic region of the data card;

FIG. **5***b* is a sectional view taken along line **5***b*—**5***b* of FIG. **5***a*;

FIG. **6***a* is a schematic illustration of still another embodiment of the present invention in which the function or information content within a "smart" chip is altered; and

FIG. **6***b* is a sectional view taken along line **6***b*—**6***b* of FIG. **6***a*.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates the functional circuit elements of a wallet-size data (credit or debit) card of the present invention. An RF signal is broadcast from a remote source **10** and is picked up on the data card **12** by antenna **14**. The RF signal source **10** can be an FM radio station, a low earth orbiting satellite, a dedicated transmitter, or any other broadcast source.

After being detected by RF detector **16** and amplified by amplifier **18**, the incoming RF signal is decoded by decoder circuit **20**. The decoding step includes recognition of a card identification code, much as a conventional pager recognizes when a received transmission is addressed to it. In response to addressing of the card and an appropriate command, decoder **20** suitably applies an appropriate control signal to a power gate **22** through conductor **21**, whereupon gate **22** extends

power from regulator **24** to transducer **30**. Transducer **30**, as will be described in greater detail below, is designed to alter a characteristic indicative of the status or activation (validation) of card **12**. Power for regulator **24** is derived from thin battery **26**, or an optional photocell **28**. Photocell **28** can be used either as an independent source of power or as a means to recharge battery **26**.

In some applications, the command signal from decoder **20** may also be extended along line **23** to driver circuit **32** to effect additional changes. For example, if transducer **30** takes the form of a liquid crystal display, the signal fed through driver circuit **32** can be used to change the display. Typically, the display might be altered to indicate the telephone number of the card issuer's office in the geographic area served by the RF broadcast.

A schematic illustration of the components shown in block format in FIG. **1** is depicted in FIG. **2**. Card **12** includes a magnetic stripe **34** as is well known in the art. Magnetic stripe **34** contains information readable by point-of-sale terminals, teller machines, data readers, etc. and often contains information such as whether the card is valid or invalid. Transducer **30** of FIG. **1** comprises a coil **41** around a ferrite slug **42** within the laminated card, and is positioned over the magnetic stripe **34** so as to focus a magnetic field over the bit information in the stripe that is to be altered. Card **12** in FIG. **2** also includes a liquid crystal display area **36** laminated within the card. The blocks of FIG. **2** are included in integrated circuit **22**, and the chip is powered by battery **26** within the card.

In operation, an RF signal is received by loop antenna **14**. Depending upon the nature of the received RF signal, the display can be changed. This type of signal is useful, for example, when a card user travels to a new city and information pertinent to that city would be helpful to the cardholder. A message, common to all cardholders in that geographic region, might thus be made to appear on all of their cards.

The received RF signal may also contain coded commands for powering transducer coil **41**. The resulting magnetic field alters the orientation of the ferrite material and therefore the information on magnetic stripe **34**. For example, such a field could de-activate the card so as to render it useless.

Referring now to FIGS. **3***a* and **3***b*, the transducer of FIG. **2** is shown in cross-section as well as in plan view. Coil **41** is positioned over magnetic stripe **34**. Ferrite slug **42** forms the core of the coil and aids in focusing the magnetic field over a section of magnetic stripe **34** that contains the information to be altered. It should be noted that the energy stored in the battery may be minimal, e.g., just sufficient to generate a single brief pulse to permanently invalidate the card. However, providing a battery which allows multiple transducer powerings (in addition to constant detector operation) is preferred. For example, this would allow a card to be revalidated upon transmission of an appropriate command.

A cardholder whose account is in arrears might take steps to shield his card at all times so that it cannot be de-activated remotely. One way to overcome this is to provide unshielded card readers, i.e., when the card is actually used, it can be de-activated by the RF broadcast signal. Another alternative is for the card to automatically de-activate itself unless it periodically detects the RF signal; shielding the card would in this case be self-destructive.

FIGS. **3***c* and **3***d* represent a slightly different configuration. Here, a ferrite core **45** is provided with a wound coil **47**, either physically wound or printed, with the core gap being positioned above the magnetic stripe area to be affected. The principle of operation, however, is the same as that of the embodiment of FIGS. **3***a* and **3***b*.

Another embodiment of the present invention is schematically illustrated in FIG. **4***a* and is shown in a cross-section in FIG. **4***b*. Here, a liquid crystal display element **52** displays a number, message, code or colored area on the surface of the card to indicate status to the user or a merchant. When the card detects an appropriate RF signal, power is gated from the battery to leads **51** on the liquid crystal display element. Code signals on leads **53** change the markings or color of the display and thereby indicate the changed status of the card. (A switch between white and black is considered herein to be a change in color.) Depending on the display technology used, the display can include memory or a hysterisis effect, and therefore the display can be made to draw current only during the change of state, thus conserving power and making permanent the new status.

Referring now to FIGS. **5***a* and **5***b*, another embodiment of the present invention is schematically illustrated whereby electrochemical or electrooptical transducer **62** is made of a matrix of material such as Nitinol embedded in clear plastic; this material changes color with temperature. The material is covered by plate **61**, to which power is supplied, to generate heat, when the card status is to be changed. A clear surface laminate **63** overlays the transparent plate **61**. The Nitinol material changes color when heated, giving notice to anyone handling the card that it is no longer valid.

An alternative operating mode for the embodiment of FIGS. **5***a* and **5***b* is to change the card status by physically altering the card. When current flows through plates **61** of electrochemical transducer **62**, it creates heat in the region of heat sensitive plastic **63**. The heat sensitive plastic shrinks and thus highlights raised characters **64** on the surface of card **12**, thus rendering the card valid or invalid as the case may be.

Referring now to the embodiment of FIGS. **6***a* and **6***b*, the memory and/or activation of a "smart" card chip would be altered by an RF signal. When the decoded signal flows through conductor **75** it changes the state or information content of "smart" chip **72**.

From the foregoing description, it will be apparent that the present invention provides an alterable data card capable of directly detecting and interpreting a unique RF signal transmitted from a remote source. Moreover, it will be further apparent that the invention provides a method for the issuer of a credit card to individually and remotely control its status.

While there have been shown and described what are presently considered to be the preferred embodiments of this invention, it will be apparent to those skilled in the art that various other changes and modifications may be made without departing from the broader aspects of this invention. For example, an active power source could be omitted from the card. Instead, an AC magnetic field from a card reader could power the card, the card including a passive magnetic field pick-up and AC-to-DC converter for deriving a potential to power the chip circuits. Also, if the card includes contacts for interfacing with a reader, an internal fuse between the

contacts might be heated and blown for the purpose of de-activating the card. It is therefore to be understood that the aim of the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

I claim:

1. An alterable wallet-size data card of the type including a magnetic stripe, the card being capable of responding to a unique RF signal transmitted from a remote source, said data card comprising:

antenna means in the card for detecting said unique RF signal;

means for decoding said unique RF signal upon detection thereof;

transducer means for selectively altering a characteristic of the data card indicative of its status; and

means for operating said transducer means, in response to operation of said decoding means, to alter the status of the data card;

wherein said transducer means comprises a magnetic coil positioned over said magnetic stripe, said magnetic coil focusing flux over a portion of said magnetic stripe when said transducer means is operative.

* * * * *

US005438750A

United States Patent [19]

Venambre

[11] Patent Number: 5,438,750

[45] Date of Patent: Aug. 8, 1995

[54] METHOD OF MANUFACTURING A CHIP CARD

[75] Inventor: Jacques Venambre, IFS Plaine, France

[73] Assignee: U.S. Philips Corporation, New York, N.Y.

[21] Appl. No.: 360,185

[22] Filed: Dec. 20, 1994

Related U.S. Application Data

[63] Continuation of Ser. No. 892,099, Jun. 2, 1992, abandoned.

[30] Foreign Application Priority Data

Jun. 17, 1991 [FR] France 91 07371

[51] Int. Cl.[6] H05K 3/00

[52] U.S. Cl. 29/829; 29/827; 235/488; 235/492

[58] Field of Search 29/827, 829; 235/488, 235/492

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Primary Examiner—Carl J. Arbes
Attorney, Agent, or Firm—Ernestine C. Bartlett

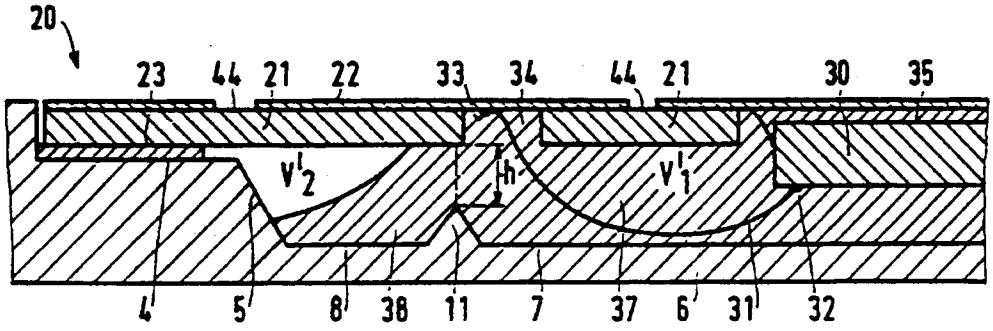
[57] ABSTRACT

A method of manufacturing a chip card comprising a card base in which a cover section is secured, which cover section comprises a circuit support and at least one microcircuit arranged on a lower surface of the circuit support, which lower surface faces the interior of a recess and is spaced from the inner surface of the bottom of the recess, in which method an encapsulant is applied to said inner surface. According to the invention the method comprises the following steps:

a) applying a metered mount of said encapsulant to a first part (7) of the inner surface of the bottom (6) of the recess, which first part is surrounded by a raised portion (11), which raised portion (11) itself is surrounded by a second part (8) of said inner surface in such manner that the encapsulant (36) is retained by capillarity by the raised portion (11), which is adapted to be spaced over at least a part of its circumference from the cover section (20) when said section is secured to the card base,

b) fixing the cover section (20) on the card base (1), the encapsulant (36) completely filling a first volume (V'_1) situated between said first part (7) and the cover section (20) and partly filling a second volume (V'_2) situated between said second part (8) and the cover section (20).

4 Claims, 2 Drawing Sheets



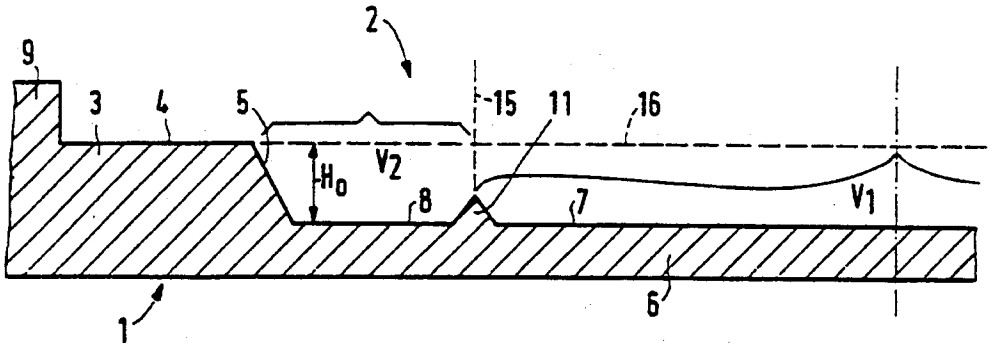


FIG.1

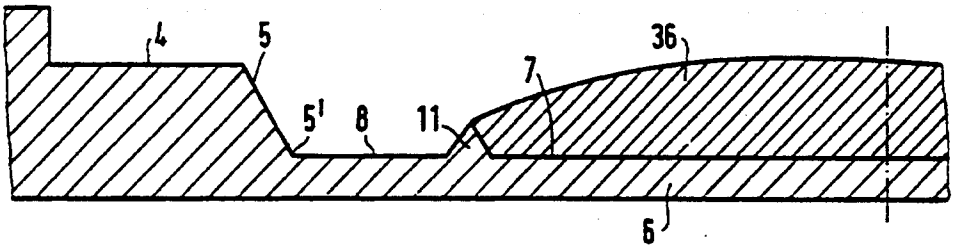


FIG.2

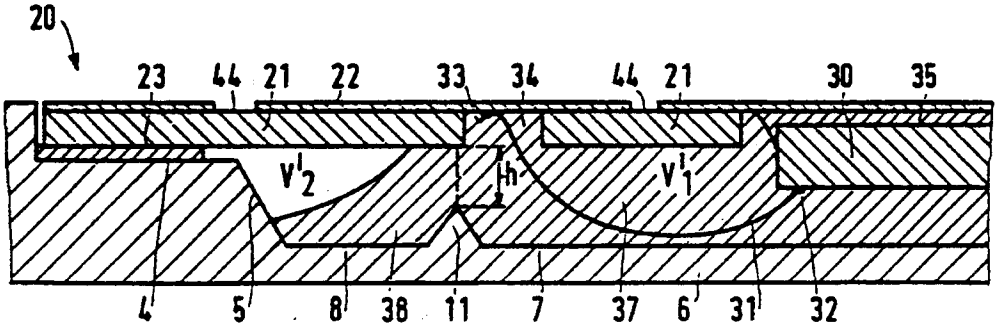


FIG.3

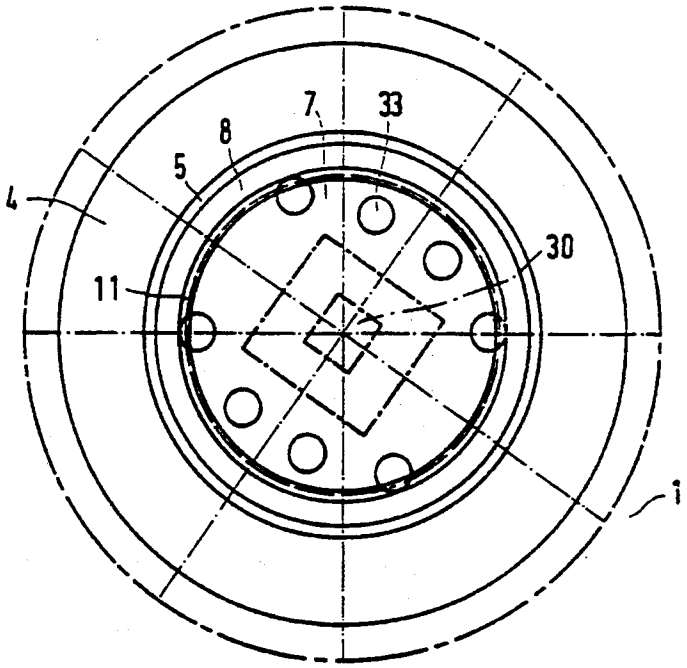


FIG.4

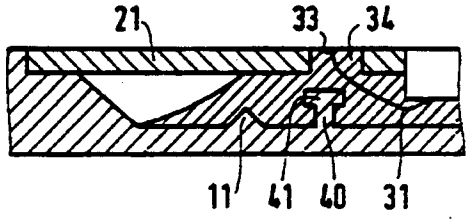


FIG.5

METHOD OF MANUFACTURING A CHIP CARD

This is a continuation of application Ser. No. 07/892,099, filed Jun. 2, 1992, now abandoned.

FIELD OF THE INVENTION

The invention relates to a method of manufacturing a chip card comprising a card base in which a cover section is secured, which cover section comprises a circuit support and at least one microcircuit arranged on a lower surface of the circuit support, which lower surface faces the interior of a recess and is spaced from the inner surface of the bottom of the recess, in which method an encapsulant is applied to said inner surface.

BACKGROUND OF THE INVENTION

Such a method is known from the Applicant's European Patent Application 201,952 filed on 10 Apr. 1986. In accordance with this prior document a given amount of encapsulant is introduced into the recess of the card by means of an automatic metering device, after which the cover section is fitted and the card is reversed. The encapsulant then flows onto the integrated-circuit chip but remains in the recess because this is closed by the cover section. This method improves the resistance to repeated bending of the card but it does not guarantee a reproducible encapsulation of the circuit. However, for an optimum reliability of the card it is desirable that the integrated circuit and its connection wires are wholly encapsulated.

Techniques for the complete encapsulation of a chip card are known but they all exhibit comparatively large drawbacks, in particular a fairly large number of process steps.

European Patent Application 075,351 filed in the name of the Applicant and N. V. Philips on 7 Sep. 1982 teaches to arrange an integrated circuit on the bottom of a cavity in a base, which integrated circuit is electrically connected to metallised tracks on the two surfaces of the auxiliary support. Subsequently, the cavity is filled with an insulating wax which, once it has solidified, holds the integrated circuit and the connection wires in position. For this purpose a frame is arranged on the support 11 around the cavity. The assembly thus obtained consequently does not exhibit a flat surface because the frame constitutes a thicker portion, the method not being applicable in any case to a card in accordance with the cited document 201,952.

Moreover, European Patent 107,061 (N. V. Philips) describes a card having a card base formed with a cavity open to both surfaces of the card. The circuit support (4) is covered with a foil (6) at its lower surface, the circuit (5) is arranged on the foil (6) through an opening (10) in the circuit support, and subsequently the connection wires are arranged between the circuit and the circuit support. After this, an annular sealing element (8) is arranged on the circuit support so as to surround the circuit and the connection wires, and subsequently a filling substance (9) is applied in order to embed the circuit and the wires, after which the foil (6) is removed. This method has the drawback that as a result of filling with a resin it is not possible to obtain a flat surface owing to the precision attainable with automatic metering devices and owing to the capillarity effect. Therefore, a finishing operation is necessary to give the card a flat surface. This is a drawback common to all the techniques in which the cavities are filled via the back.

Thus, the cards manufactured by Messrs. Schlumberger employ a card base having a hole accommodating a polyester printed circuit MCTS carrying an integrated circuit, filling with an epoxy resin being effected via the back, after which the surplus resin is subjected to a finishing operation. It is to be noted also that, as a result of the materials used, this method has the drawback that the device is visible, which poses a problem with respect to the appearance of the product.

Another total encapsulation technology is used by Siemens. A chip is interconnected to a film by gold pads and is accommodated in a cavity in an inner layer of a card base comprising a plurality of PVC layers. This technique, which requires a plurality of layers to be stacked, is expensive.

It is an object of the present invention to solve the problem of the production costs of "total encapsulation" cards.

Until now the technology corresponding to European Patent 201,952 has been used, in which the connection wires are encapsulated only partly or not at all, the product being designed to withstand bending tests. For this, reference is made to, for example, French Patent Application FR 2,617,668 (RTC-Compelec). The card base in accordance with this technology can be realised at low cost (by moulding) and the embedding process as described in European Patent 201,952 can be automated very easily.

A known total encapsulation technology suitable for a card having a recess for a cover section is to apply and to polymerise a drop of epoxy resin on an integrated device so as to encapsulate the assembly comprising the device and the connection wires (cf. French Patent Application published under number FR 2,583,574 filed by La Société Eurotechnique on 14 Jun. 1985). In practice, a mechanical finishing operation is necessary because the applied drop forms a dome of a height H, which height must be reduced in practice in order to achieve that the thickness of the combination of printed circuit, chip and encapsulation does not exceed the limits imposed by the dimensions specified for a chip card (nominal thickness 0.8 mm). In practice, this height reduction is obtained by machining the dome so as to flatten it substantially down to the level of the connection wires.

SUMMARY OF THE INVENTION

The basic idea of the invention is to use the first method mentioned in the present Patent Application (opening paragraph, p. 1) for manufacturing totally encapsulated cards without any machining operation and without imposing a particular value on the card thickness.

To this end a method in accordance with the invention is characterised in that the method comprises the following steps:

a) applying a metered amount of said encapsulant to a first part of the inner surface of the bottom of the recess, which first part is surrounded by a raised portion, which raised portion itself is surrounded by a second part of said inner surface in such manner that the encapsulant is retained by capillarity by the raised portion, which is adapted to be spaced over at least a part of its circumference from the cover section when said section is secured to the card base,

b) arranging the cover section on the card base, the encapsulant completely filling a first volume situ-

ated between said first part and the cover section and partly filling a second volume situated between said second part and the cover section.

The second volume around the raised portion serves to take up the excess encapsulant, which settles on the second part of said inner surface, as a result of which it is mechanically reinforced. This simplifies the production steps to a maximum extent, no grinding being necessary, of course. Curing of the encapsulant is suitably effected at ambient temperature. Since the cavity is closed by the cover section it is possible to test and sort out the cards before curing of the encapsulant, the purpose of this curing being merely to protect the card when it is subjected to substantial mechanical loads. Suitably, the encapsulant is a semi-rigid resin (for example, a hardness of D70 Shore) conforming to bending loads imposed by the bending tests (for example, epoxy resin ME45W from Emerson and Cuming France).

In a preferred embodiment, providing a high mechanical stability, the first volume is such that the microcircuit and the electrical connection wires between said microcircuit and the circuit support are wholly encapsulated by the encapsulant.

The invention also relates to a chip card comprising a card base having a recess in which a cover section is secured, which cover section comprises a circuit support and at least one microcircuit arranged on a lower surface of the circuit support, which lower surface faces the interior of the recess and is spaced from the inner surface of the bottom of the recess.

Such a card is known from the cited document EP 201,952.

In accordance with the invention the inner surface of the bottom of the recess comprises a raised portion which is spaced from the cover section over at least a part of its circumference, which raised portion surrounds a first part of said inner surface and is itself surrounded by a second part of said inner surface, a first volume situated between said first part and the cover section being completely fried with an encapsulant, and a second volume situated between said second part and the cover section being partly filled with said encapsulant.

The second volume serves as an expansion chamber for the first volume which is wholly filled with the encapsulant.

In a preferred embodiment providing total encapsulation said first part extends at least up to a location above which the circuit support carries solder points for the electrical connection wires between the circuit and the circuit support.

In an advantageous embodiment said encapsulant which partly fills the second volume wholly covers said second part.

The raised portion may be annular and/or of triangular cross-section.

Said first part may comprise anchoring elements for an improved mechanical stability of the assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail, by way of non-limitative example, with reference to the accompanying drawings, in which:

FIG. 1 is a sectional view showing a part of a card base of a card in accordance with the invention,

FIG. 2 is a sectional view showing a part of said card base after filling with the encapsulant (step a),

FIG. 3 is a sectional view showing a part of the finished chip card,

FIG. 4 is a plan view of the recess of the card base, also showing the solder points of the wires and the circuit 30, and

FIG. 5 shows a modification of FIG. 4.

DESCRIPTION OF EMBODIMENTS

FIG. 1 is a sectional view of a card base beating the general reference 1 and having a recess bearing the general reference 2 and formed in a card body 9. The recess 2 is adapted to receive a cover section which bears the general reference 20 in FIG. 3 and which comprises a microcircuit 30 and a microcircuit support 21. The recess 2 has an outer rim 4 for affixing the cover section 20 by means of an adhesive 23 (FIG. 3), which rim is connected to the inner surface of the bottom 6 of the recess 2 by a flared portion 5 (see also FIG. 4). A raised portion 11 forms an annular barrier of triangular cross-section which surrounds and bounds a circular part 7 of the inner surface of the bottom 6 of the recess 2. An annular part 8 of the inner surface of the bottom 6 surrounds the raised portion 11 and thus extends up to the edge 5' of the flared portion 5. A cover section 20 comprises a circuit support 21 of an insulating material and a conductive layer 22 comprising conductor tracks separated by openings such as 44, dividing them electrically into different zones to insulate of the electrical contacts points. A microcircuit 30 is glued to the layer 22 at 37. Connection wires 31 are soldered to the microcircuit 30 (at 32) and the layer 22 (at 34). For a more detailed description reference is made to the Applicant's French Patent application FR 2,580,416 filed on 12 Apr. 1985.

FIG. 2 illustrates the first step of the embedding process. A predetermined amount of an encapsulant, for example the two-component epoxy resin ME45W from Emerson and Cuming (semi-rigid resin particularly intended for chip cards) prepared in a proportion of 100 parts of component A to 40 pans of component B, is applied in such a way that by capillarity a dome 36 is formed on the part 7 of the bottom 6 without overflowing owing to the raised portion 11. Preferably, a multiple volumetric deposition system is used for a satisfactory distribution of the drop forming the dome 36.

V_1 is defined as the volume bounded by the part 7, the cylinder 15 tangent to the apex of the raised portion 11 and the plane 16 of the outer rim 4, and V_2 as the volume bounded by the annular part 8, the cylinder 15, the flared portion 5 and the plane 16. H_o is the distance between the plane 16 and the inner surface (7, 8) of the bottom 6. The volume of the dome 36 is larger than V_1 and smaller than V_1+V_2 by an amount to be explained with reference to FIG. 3. It is to be noted the use of an annular raised portion 11 to retain a drop of resin is known per se from Swiss Patent 619,333 filed by Faselec AG on 1 Nov. 1977. In accordance with said Patent a semiconductor is arranged inside the annular space defined by the raised portion and is encapsulated with a resin, which remains on the raised portion by capillarity. In accordance with this prior art, once the resin has been deposited in such a manner that the dome encapsulating the device has the desired shape, the resin is polymerised and encapsulation is finished. The resin keeps its dome shape, with all the drawbacks mentioned hereinbefore.

Conversely, in accordance with the invention, the cover section 20 is subsequently arranged on the rim 4,

preferably by means of an adhesive **23**, the circuit **30** facing the interior of the recess **2**. The cover sections **20** are cut by the insertion machine and they are positioned above the recess **2** and pressed onto the card base to ensure adhesion to the applied adhesive **23**. The excess amount **38** of encapsulant of the dome **36** flows in outward directions over the upper edge of the raised portion **11** (having a distance h from the cover section) and spreads on the annular portion **8** without contacting the adhesive **23** which may be present. During this operation air bubbles present in the encapsulant are also expelled.

V'_1 is the volume bounded by the part **7**, the cylinder **15** and the cover section **20** once fitted. The remaining encapsulant **37** fills the volume V'_1. V'_2 is the volume bounded by the part **8**, the cylinder **15**, the flared portion **5** and the cover section **20**. The excess amount **38** of encapsulant needs to fill the volume V'_2 only partly. If the thickness of the adhesive **23** is ignored this means that V'_2 is substantially equal to V_2. In contrast, V'_1 is smaller than V_1 because the circuit **30** extends inside the recess **2** above the part **7** ($V'_1 < V_1$). The volume of the encapsulant to be applied in order to form the dome **36** should comply with

$$V_p < V_1 + V_2 \approx V_1 + V_2$$

If V_{IC} is the volume of the circuit **30** one may write

$$V_p < V_1 + V_2 - V_{IC}$$

It is obvious that in practice allowance is to be made for variations of the volume of the resin during its polymerisation.

Since the recess **2** is sealed hermetically as a result of the cover section **20** being glued into said recess the encapsulant need not be cured rapidly. Of course, the card should not be subjected to excessive mechanical stresses until polymerisation is complete but it is possible to test, sort out and stock the cards. The afore-mentioned resin ME45W polymerises in 24 hours at ambient temperature.

The raised portion **11** is situated at a distance h from the underside of the circuit support **21** once the latter has been mounted in the recess **2**. This allows the encapsulant **36** to flow towards the volume V'_2 situated above the annular part **8**.

As a result of this, the raised portion **11** need not be spaced from the cover section **20** over its entire circumference. It is adequate if the raised portion has one or more passages for the encapsulant **36**.

In accordance with the invention the drawbacks of the prior art are thus avoided, particularly the need to machine the encapsulant mechanically in order to keep the thickness of the card within the specified tolerances.

The card base **2** can be made of polyvinyl chloride, the recess being formed by machining, or preferably of a mouldable material (ABS).

The dimensions of the cover section and the shape and the dimensions of the recess **2** may be adapted to receive large chips **30** ($\approx$20 mm^2).

The shapes, particularly of the raised portion **11**, are not necessarily rotationally symmetrical and may be adapted to the geometry of the device and the solder points **33** of the cover section.

Preferably, the solder points **33** of the cover section lie within the perimeter of the raised portion **11** (V'_1) (see FIG. **4**) to ensure that the ends of the wires are embedded. This is an important requirement affecting the reliability of the product because partial encapsulation of a wire may lead to its breakage during bending tests, a discontinuity in the encapsulation resulting in a substantial and local increase of the stresses exerted on the wire.

EXAMPLE

outer diameter of the rim **4**: 16.3 mm,
inner diameter of the rim **4**: 11.3 mm,
diameter at the edge **5'** of the portion **5**: 10.7 mm,
inner diameter of the raised portion **11**: 8.8 mm,
outer diameter of the raised portion **11**: 9.4 mm,
height of the raised portion **11**: 0.2 mm,
distance H_c: 0.6 mm,
volume of the applied resin: approximately 38 mm^3.

The crushing strength of the module comprising the cover section plus encapsulation is excellent, which contributes to the reliability of the product and mitigates the problem of magnetic losses as a result of a deformation of the cover section **20** and the card bottom **6** while passed through magnetic-track readers.

Fillers may be added to the encapsulant to improve its thermal conduction and/or to protect the device against electrostatic fields.

The adhesion of the encapsulant may be improved by providing the card bottom **6** with anchor elements (**40**, **41**) (FIG. **5**) to increase the area of contact between the resin and the card bottom.

The strong adhesion between the encapsulant **36** and the and the card bottom **6** also guarantees that the cover section **20** is non-removable (which is an important feature for certain uses). Any attempt to detach the cover section **20** will result in the device being destroyed (tearing loose of the wires **31** and loosening of the chip **30**).

The invention is not limited to the embodiments described and shown herein. The raised portion **11** need not be continuous. It should merely be capable of retaining a drop of encapsulant by capillarity. It may be constituted, for example, by a series of spaced-apart pegs arranged on a continuous base. The spacings between the pegs then form the spacings between the raised portion **11** and the cover section.

The invention relates to all types of card, including contactless cards, which may not comprise electrical connection wires.

The term card is not to be taken in its strictest sense. The invention also applies to ail types of flat supports, such as for example remote-control keys for locking automobiles.

I claim:

1. A method of manufacturing a chip card comprising a card base in which a cover section is secured, which cover section comprises a circuit support and at least one microcircuit arranged on a lower surface of the circuit support, which lower surface faces the interior of a recess and is spaced from the inner surface of the bottom of the recess, in which method an encapsulant is applied to said inner surface, characterised in that the method comprises the following steps:

a) applying a metered amount of said encapsulant to a first part (**7**) of the inner surface of the bottom (**6**) of the recess, which first part is surrounded by a raised portion (**11**), which raised portion (**11**) itself is surrounded by a second part (**8**) of said inner surface in such manner that the encapsulant (**36**) is retained by capillarity by the raised portion (**11**),

which is adapted to be spaced over at least a part of its circumference from the cover section (20) when said section is secured to the card base,

b) arranging the cover section (20) on the card base (1), the encapsulant (36) completely filling a first volume (V'_1) situated between said first part (7) and the cover section (20) and partly filling a second volume (V'_2) situated between said second part (8) and the cover section (20).

2. A method as claimed in claim 1, characterised in that the encapsulant (36) is cured at ambient temperature.

3. A method as claimed in claim 1 characterised in that the encapsulant (36) is a semi-rigid resin.

4. A method as claimed in claim 1 characterised in that the first volume (V'_1) is such that the microcircuit (30) and electrical connection wires (31) between said microcircuit and the circuit support (21) are wholly encapsulated by the encapsulant.

* * * * *

US005448110A

United States Patent [19]

Tuttle et al.

[11] Patent Number: 5,448,110

[45] Date of Patent: Sep. 5, 1995

[54] **ENCLOSED TRANSCEIVER**

[75] Inventors: **John R. Tuttle**, Boise; **Rickie C. Lake**, Eagle, both of Id.

[73] Assignee: **Micron communications, Inc.**, Boise, Id.

[21] Appl. No.: **123,030**

[22] Filed: **Sep. 14, 1993**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 899,777, Jun. 17, 1992.

[51] **Int. Cl.**[6] **H01L 23/16**

[52] **U.S. Cl.** **257/723**; 257/724; 340/825.54

[58] **Field of Search** 257/723, 724, 679; 340/825.34, 825.54, 573, 572; 455/89, 90

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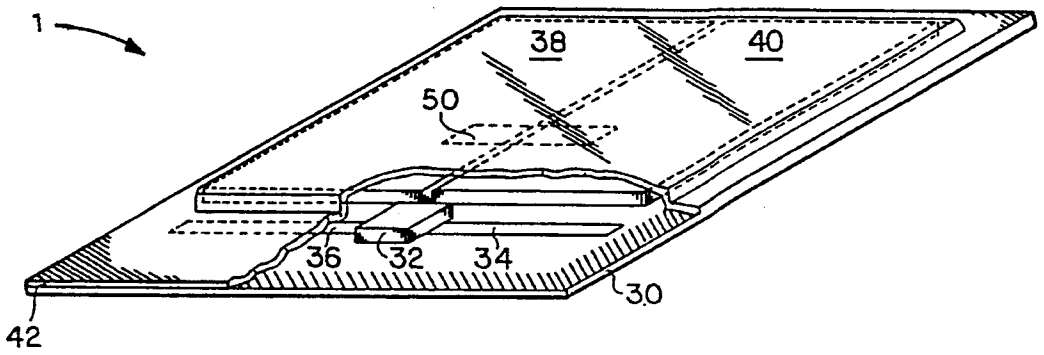
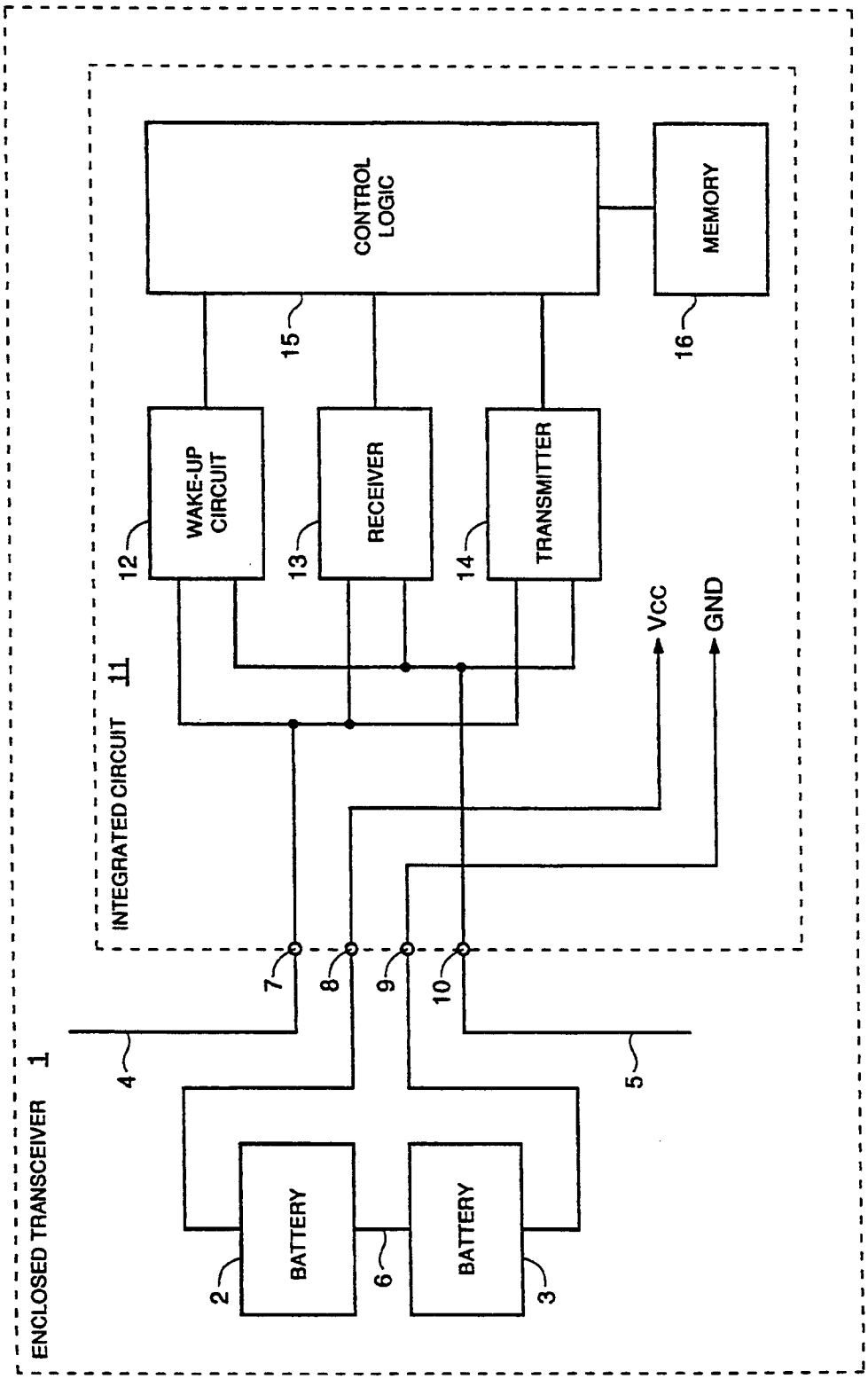
Primary Examiner—Sara W. Crane
Assistant Examiner—S. V. Clark
Attorney, Agent, or Firm—William R. Bachand

[57] **ABSTRACT**

An enclosed transceiver includes an integrated circuit and a battery together laminated between two films. Printed conductors on each film couple operative power to the integrated circuit. Other-printed conductors form an antenna coupled to the transceiver for sending and receiving signals. In a preferred embodiment, the integrated circuit has three terminals. The first terminal is connected to a first side of a thin film battery. The second terminal is connected to a first side of a printed loop antenna. The third terminal serves two purposes being connected to the second side of the battery and to the second side of the loop antenna. The enclosing films are treated with silicon nitride for hermeticity. Enclosed transceivers of the present invention are suitable for mass production in web, sheet, and tape formats. Such transceivers are useful as stamps, labels, and tags in object tracking systems including systems for mail delivery, airline baggage tracking, and inventory control.

9 Claims, 10 Drawing Sheets

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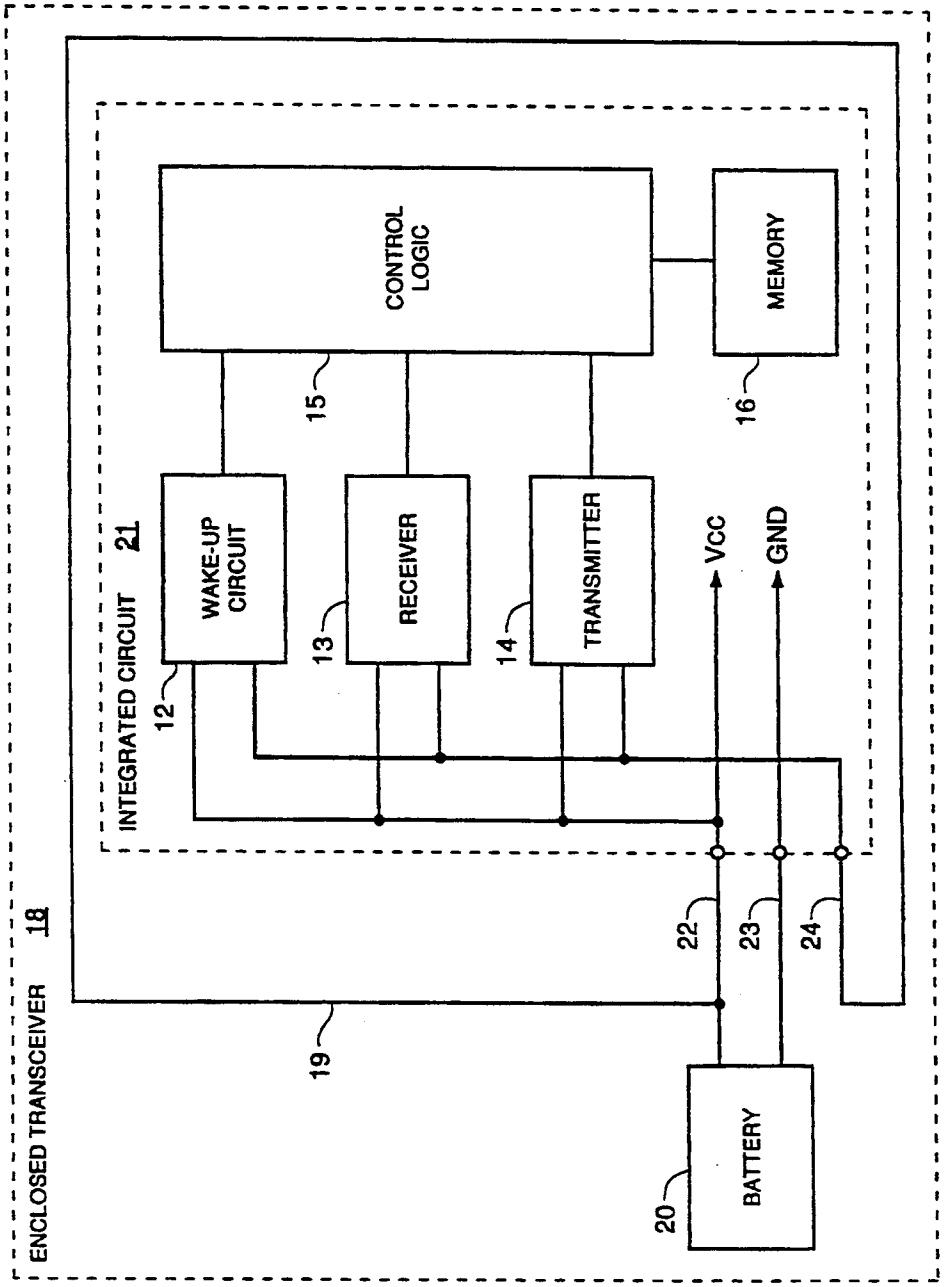
INTEGRATED CIRCUIT 11
CONTROL LOGIC
MEMORY
WAKE-UP CIRCUIT
RECEIVER
TRANSMITTER
Vcc
GND
BATTERY
BATTERY
12
13
14
15
16
2
3
4
5
6
7
8
9
10

FIG. 1A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INTEGRATED CIRCUIT 21
CONTROL LOGIC
MEMORY
WAKE-UP CIRCUIT
RECEIVER
TRANSMITTER
Vcc
GND
BATTERY
12
13
14
15
16
19
20
22
23
24

FIG. 1B

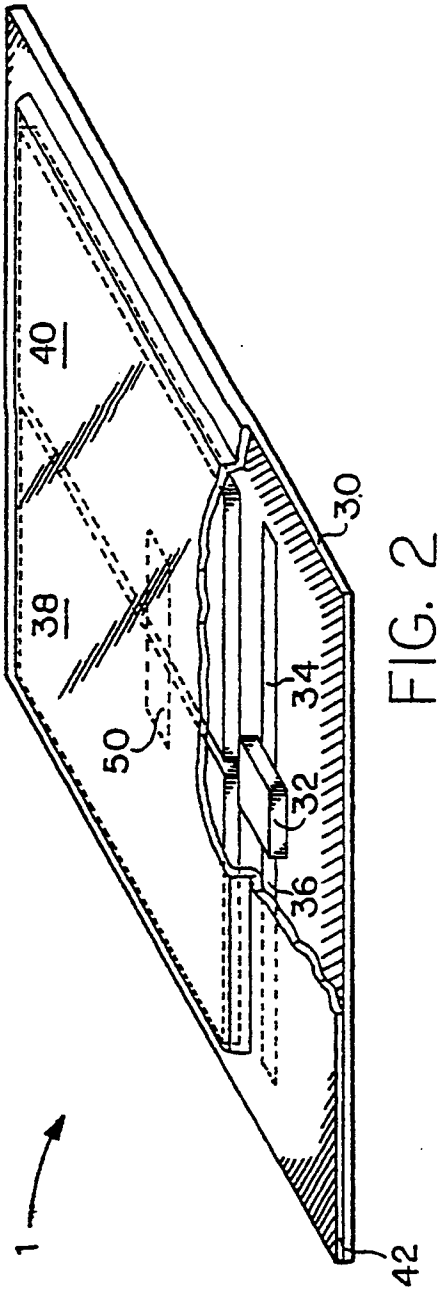

FIG. 2